NIU/ICSW/BRI/033

ISDN Basic Rate Interface Wiring and Powering Guidelines for Commercial and Multi-Tenant Residential Buildings

Version 2 (Single and Multi-Tenant High Rise Buildings, Campuses, Strip Malls, and Specialized Applications)

Disclaimer

THIS DOCUMENT INTENDED TO PROVIDE INFORMATION CONCERNING, BUT NOT LIMITED TO, GUIDELINES FOR POWERING AND WIRING FOR ISDN. THESE GUIDELINES WERE DEVELOPED AND APPROVED BY ORGANIZATIONS PARTICIPATING IN THE NORTH AMERICAN ISDN USERS' FORUM (NIUF) AS OF JUNE, 1996. NEITHER THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY NOR ANY OF THE PARTICIPANTS IN THE NIUF MAKE ANY REPRESENTATION OR WARRANTY, EXPRESS OR IMPLIED, WITH RESPECT TO THE SUFFICIENCY, ACCURACY, OR USE OF ANY INFORMATION OR OPINION CONTAINED HEREIN. THE USE OF THIS INFORMATION OR OPINION IS AT THE RISK OF THE USER. UNDER NO CIRCUMSTANCES SHALL NIST, OR ANY PARTICIPANT IN THE NIUF BE LIABLE FOR ANY DAMAGE OR INJURY INCURRED BY ANY PERSON ARISING OUT OF THE SUFFICIENCY, ACCURACY, OR USE OF ANY INFORMATION OR OPINION CONTAINED HEREIN.

ISDN BRI Wiring and Powering Guidelines for Commercial and Multi-Tenant Residential Buildings

Table of Contents

1. Introduction

1.1 Purpose

Integrated Services Digital Network (ISDN) is a digital communications technology that is gaining widespread acceptance in the commercial and residential environment. The purpose of this document is to provide guidelines for wiring and powering for ISDN in commercial and multi-tenant (e.g., apartment) buildings. This document is intended for wiring installers, engineers, and project planners, to facilitate the planning and installation of wiring and powering for ISDN.

1.2 Scope

This document addresses wiring and powering practices for planning and installation of Basic Rate Interface (BRI) ISDN in commercial and multi-tenant residential buildings for new and existing facilities. This document recognizes that adherence to wiring standards will make the wiring more flexible for multiple applications, and consequently promotes standard wiring practices. In addition, local building, fire, and electrical codes applicable in your area must be followed.

1.3 Structure

Sections 1.4 and 1.5 of this document contain background material on the terminology and components for the planning or installation of ISDN. These sections include information concerning the demarcation point (demarc), cables and connectors, ISDN equipment, and terminology applicable for commercial and multi-tenant residential applications.

Sections 2 through 5 contain general information that may apply to any building configuration. Section 2 describes alternatives for the wiring and placement of terminal equipment and powering equipment, based on the location of the demarc. Section 3 provides guidelines for the planning of telecommunications systems (e.g., use of new wiring or existing wiring). Section 4 contains a summary of cabling practices as defined by several standards bodies. Section 5 provides guidelines for ISDN specific wiring and powering considerations such as the placement of NT1s and powering equipment, and point to point and multipoint configurations in the work area.

Section 6 contains additional information about wiring and powering for single tenant high rise buildings and multi tenant high rise buildings. Section 7 contains additional information about wiring and powering for a campus environment. Section 8 contains additional information about wiring and powering for a strip mall. Section 9 contains additional information about wiring and powering for a specialized applications, such as emergency services buildings.

1.4 ISDN Definitions and Terminology

1.4.1 Introduction to ISDN Terminology

This section provides an overview of ISDN wiring terminology, including the following topics:

- ISDN Connectors
- ISDN Outlets
- ISDN Cords
- ISDN Cable
- Demarcation point (Network interface)
- U interface
- Network Termination 1 (NT1)
- Terminating resistors
- NT1 timing
- S/T interface
- Terminal Equipment (TE)
- Extension phones and the R interface

If you are already familiar with these terms, you may wish to skip this section. For more details on these terms or any other ISDN terminology in this document, see NIUF/ICSW/BRI/022 - ISDN Wiring and Powering Guidelines (Residence and Small Business).

1.4.2 ISDN Components

1.4.2.1 Connectors

Before we discuss ISDN telephones and other similar components, it is important to spend some time on the most basic items involved in providing proper wiring for ISDN. One of these basic items is the so-called modular connector (i.e., modular plugs and modular jacks) that have been used in recent years by the telephone industry. There are two that are of particular interest — the modular 6-position jack/plug and the modular 8-position jack/plug shown in Figure 1-1. The modular 6-position jack/plug is often referred to as an RJ-11 jack/plug and the modular 8-position jack/plug is often referred to as an RJ-45 or RJ-61 jack/plug. While the RJ-11, RJ-45 and RJ-61 designations are commonly used, there are situations when they might cause some confusion. Thus, we will use the more generic 6-position and 8-position terminology here.

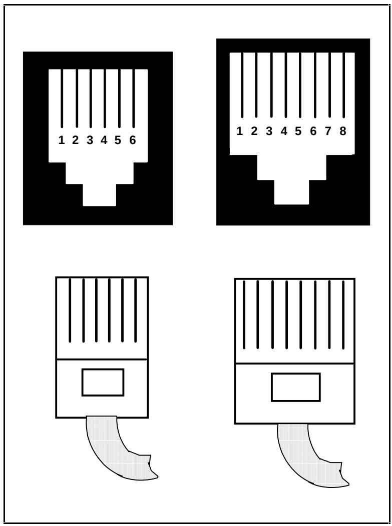

Figure 1-1 6- and 8-position Modular Connectors

Note: Above jacks are as viewed looking into opening. Shown larger than actual size.

The connector normally used for ISDN service/equipment is the modular 8-position jack/plug mentioned above. *New installations are required by the FCC to be installed with a modular 8-position plug/jack.* Although not typically used for POTS in a residence, modular 8-position connectors are often used for data services. Unlike the modular 6-position plug/jack where some of the pins are often not present, the 8-position plug/jack typically has all eight positions equipped with pins.

A modular 8-position plug/jack with only the center two pins wired is referred to as an ~~*SJA-11*~~ *RJ-49C (see Figure 1-2a). Note that this type of connector may also be designated SJA-11*. Similarly a modular 8-position plug/jack with all eight pins wired is referred to as a T568A connector if the wiring is as shown in Figure 1-2b. However, a modular 8-position plug/jack might also be a T568B connector similar to a T568A except with pairs 2 and 3 swapped (see Figure 1-2c). The applicable color coding for wiring an ISDN connector using the recommended 4 pair twisted wire is as shown in Table 1-1.

It is worth noting that, despite the difference in width, a modular 6-position plug can be inserted into a modular 8-position jack. The construction of the 6- and 8-position connectors is such that the pins in the 6-position plug will align with the pins in the six center positions of the 8-position jack. For example, if the center four pins are present in a 6-position plug they will align properly with the center four pins in an 8-position jack. While the use of a 6-position plug in an 8-position jack is not recommended, it can be used without fear of mismatching between the plug and jack pins.

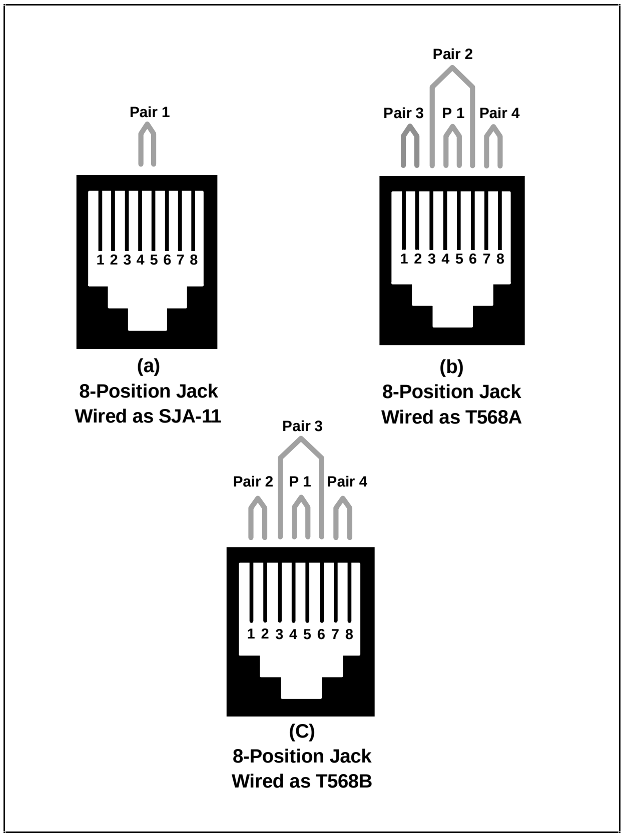

Figure 1-2 Some typical connector wiring configurations

Note: Above jacks shown larger than actual size.

1.4.2.2 Outlets

The recommended jack/wall outlet for ISDN service is the modular 8-position jack referenced earlier. If that type of jack is used wherever one is needed, there should not be any connector compatibility problems since that jack can receive either an 8-position or a 6-position modular plug. **It may be possible to use existing 6-position jacks/wall outlets but there is a high likelihood of encountering compatibility problems (e.g., your ISDN components will likely have 8-position plugs).** While it is possible to buy or make adapters to deal with almost any incompatibility problem, it seems a more realistic approach to simply use the proper jacks to start with.

1.4.2.3 Cords

There are two types of cords commonly used with terminal equipment; one is a line cord and the other is an extension cord. Although cords are relatively simple, the reader should be aware that there is a difference between POTS cords and ISDN cords. A pair reversal arrangement is usually built into a POTS cord, but such a reversal is not acceptable for ISDN cords — they must be wired on a "straight through" basis. A pair reversal is not a problem on the U-interface (see Section 1.4.2.6.1) portion of the layout — if, for example, a reversal type cord was used between a U-interface wall jack and an NT1 (see Section 1.4.2.6.2) there would not be a problem. The reversal problem arises in connection with the S/T interface (see Section 1.4.2.6.2) if multiple terminals are connected to it. The polarity of any individual terminal is not critical, but it is critical that all terminals on the same S/T interface be wired using the same polarity. The simplest way to avoid cord-related problems is to avoid the use of reversal-type cords for ISDN. Some straight through and reversal types of cords are shown in Figure 1-3. It should also be noted that ISDN technical specs call for limiting the length of ISDN line cords to 33 feet (10 meters) or less.

Conductors	**EIA/TIA** Standards **Twisted pair** color coding	8-pos. pin # T568A	 T568B
Pair 1	White-Blue* Blue **	5 4	5 4
Pair 2	White-Orange* Orange **	3 6	1 2
Pair 3	White-Green* Green **	1 2	3 6
Pair 4	White-Brown* Brown **	7 8	7 8

Conductors	**Twisted pair** color coding	6-pos. pin # T568B
Pair 1	White-Blue* Blue **	4 3
Pair 2	White-Orange* Orange **	2 5
Pair 3	White-Green* Green **	1 6

* The wire insulation is white with a colored marking (typically a stripe) added for identification.

** A white marking (typically a stripe) is optional.

Table 1-1 Premises Wiring Color Code

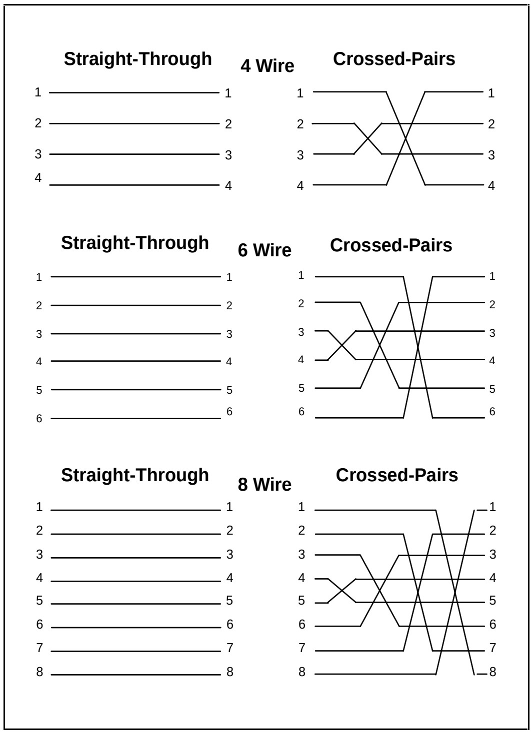

Figure 1-3 Straight-through and pair-reversal cords

1.4.2.4 Cable

In addition to cords and connectors, another basic ingredient for providing ISDN service is the cable itself. Until the early 1980's, the telephone company was responsible for telephone wiring in homes and businesses. Subsequently, customer premises wiring has been the responsibility of the home/building owner. Even when the telephone company was responsible for wiring, multiple cable types were used for wiring.

A wide variety of telephone cabling already exists in customer premises. Even quad cable which has been widely used by the telephone industry has no single standard. Thus, if your ISDN installation plans include the possibility of using existing wiring, caution is recommended. There is no simple way to evaluate existing cabling — it may or may not be satisfactory. Probably the best way to determine whether existing wiring is satisfactory for ISDN use is to try it. If there is any doubt, use new wiring as specified in the next paragraph. Section 3 gives additional details on the choice of new or existing wiring.

If new cabling is to be installed, in either an existing or a new building, it is strongly recommended that the standards set forth by the Electronic Industries Association (EIA) and the Telecommunications Industry Association (TIA) be followed. The EIA/TIA recommended minimum wiring is 8-conductor (4-pairs) *unshielded* twisted pair (UTP), category 3 or higher, 24 gauge. Category 4 or 5 cable is satisfactory for ISDN service although it exceeds the requirements necessary for ISDN and is somewhat more expensive than category 3 cable.

1.4.2.5 The Demarcation Point

The Demarcation Point (demarc) represents the interface between the service provider's telecommunications network and the network of the building(s). This point is also sometimes known as the network interface (NI) since it is where the responsibility of the network service provider (i.e., typically the telephone company) meets or "interfaces" with the responsibility of the home or building owner. In other words, the ISDN demarc is the same as the POTS demarc. In this document the term demarc will be used instead of the term network interface. The location of the demarc in commercial and multi-tenant buildings may vary. See Section 2 for additional details.

1.4.2.6 ISDN Equipment and Interfaces

With normal telephone service (POTS), nothing really changes between the demarc and the terminal equipment (i.e., the telephone set) - the same electrical signals that arrive at the demarc from the telephone company central office continue on to the telephone set over two wires. However, with ISDN, an additional component is required between the demarc and the ISDN terminal equipment (see section 1.4.2.6.5). That additional component is called a **Network Termination 1** (NT1). The NT1 is described in more detail in section 1.4.2.6.2. Figure 1-4 shows a simplified layout of the items mentioned below.

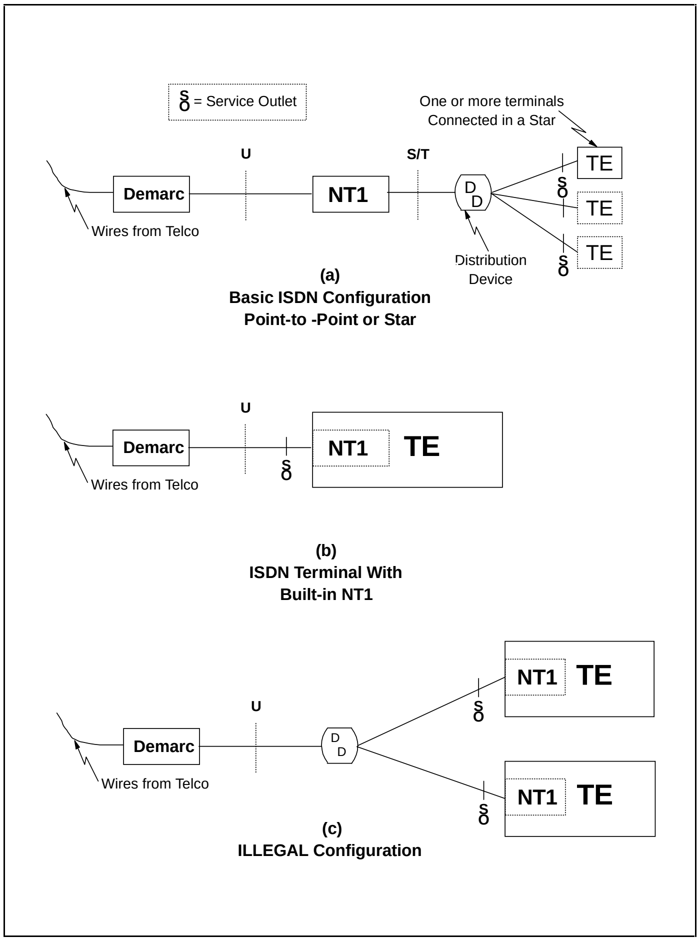

Figure 1-4 Examples of ISDN equipment configurations

1.4.2.6.1 U Interface

As indicated previously, there is much jargon associated with ISDN. One common term is "interface." One of the interfaces frequently referred to is the **U interface**. As shown in Figure 1-4a or 1-4b, the U interface is simply any point along the pair of wires from the telephone office after they have passed through the demarc and before they get to the NT1. Thus, the term U interface does not refer to a specific connection point like the demarc, but rather represents certain electrical characteristics, defined by the ISDN technical standards, that occur on a 2-wire transmission path.

1.4.2.6.2 Network Termination 1 (NT1) and S/T Interface

As mentioned above, one of the items in the ISDN arsenal of new terminology and technology is something known as the NT1 (Network Termination 1). One side of the NT1 connects to the U-interface. The NT1 converts the signal arriving on the 2-wire U interface to a 4-wire electrical signal known as the S/T interface. The NT1 may be almost adjacent to, or a considerable distance from, the demarc. There are several significant points worth noting at the outset of our discussion:

• The NT1 may be a standalone piece of equipment (Figure 1-4a) or it may be built into an item of terminal equipment such as an ISDN telephone (Figure 1-4b). An ISDN terminal with a built-in NT1 is sometimes called a U interface terminal.

• There can be only one NT1 connected to a U interface. Thus, if multiple terminals are to be served by one ISDN line, they must be served by a single NT1 as shown in Figure 1-4a (but see note below). **Multiple U interface terminals (i.e., with built-in NT1s) are not acceptable (Figure 1-4c).**

Note: There are ISDN terminals that have a built-in NT1 with a jack that allows adding another terminal that *does not* have a built-in NT1. Thus, a standalone NT1 as shown in Figure 1-4a is not the only possible option when multiple terminals are involved.

For purposes of this discussion, the basic function of the NT1 is to convert the ISDN electrical signals that travel from the telephone office to the NT1 over the equivalent of one pair of wires (i.e., 2 signal leads) into an electrical configuration that uses 2 pairs of wires (i.e., 4 signal leads) as required by the ISDN customer terminal equipment. The wiring that runs between the NT1 and the terminal equipment is called the S/T interface as shown in Figure 1-4. Just as with the U interface, the term S/T interface does not refer to a specific connection point but rather represents specific electrical characteristics. Also, recall that in some applications the NT1 may be included in the terminal equipment (TE) so there is no exposed S/T interface. Unlike with the U interface, multiple terminal equipment devices can be connected to the S/T interface.

As mentioned earlier, the ISDN electrical signal that passes from the NT1 to the TE requires two pairs of wires (i.e., the S/T interface uses 4-wire transmission). However, the S/T interface is defined as an 8-wire interface - 4 wires for signal transmission and 4 wires for optional power arrangements. Depending upon the powering arrangements used, the S/T interface for a given installation may require only 4 or 6 of the 8 wires that are specified.

1.4.2.6.3 Terminating resistors

In order to insure the proper electrical characteristics of the signals passing over the S/T interface, the ISDN technical specifications require the use of terminating resistors. Improper placement of terminating resistors will result in unsatisfactory operation of the equipment. A detailed discussion of terminating resistors is beyond the scope of this section, but this subject is covered in later sections. The manufacturer's literature should also provide information on this subject. Figure 1-5 provides some examples of the various configurations you may encounter.

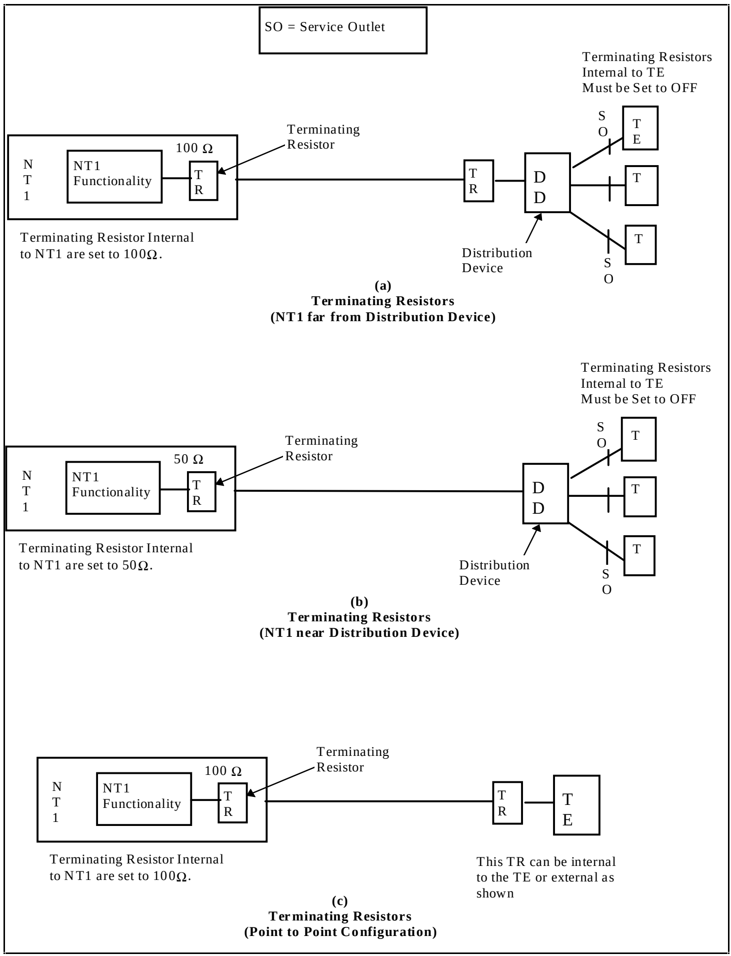

Figure 1-5 Examples of Terminating Resistor Usage

1.4.2.6.4 NT1 Timing

Some NT1s require the selection of one of two timing modes - fixed or adaptive. A discussion of NT1 timing is beyond the scope of this document, but the manufacturer's literature should provide helpful information when needed.

1.4.2.6.5 Terminal Equipment (TE)

From the customer's perspective, the terminal equipment is where the action is. Terminal equipment is the communication device, or devices, that the customer actually uses. In the POTS case, the terminal equipment is usually a telephone, but it could be a facsimile machine, a modem/computer, or whatever the customer had connected to the line to handle the desired communication. With ISDN, the concept is the same but the equipment is a bit different - it could be an ISDN telephone, a personal computer with a special plug-in board to provide an ISDN interface, an ISDN fax machine, etc. Figure 1-6a shows what a typical ISDN telephone might look like. It is shown connected to a separate NT1, but some ISDN telephones might have an NT1 built-in and thus connect directly to the U interface. Figure 1-6b shows a PC as the terminal equipment. As the reader might imagine, there are many possible terminal equipment arrangements.

In addition to the normal ISDN terminal equipment discussed above, there is a somewhat special situation that is worthy of a brief mention here. The ISDN technical literature defines a device or function known as a terminal adapter. A terminal adapter converts the ISDN signal into a form usable by non-ISDN terminal equipment. Terminal adapters are intended for both data and voice applications. A terminal adapter could be a stand-alone item as shown in Figure 1-6c or it could be built into a piece of non-ISDN terminal equipment. The arrangement shown in Figure 1-6b assumes the existence of a terminal adapter in the form of a PC plug-in card. The signal between the terminal adapter and the non-ISDN terminal equipment is defined in ISDN technical specifications as the R interface.

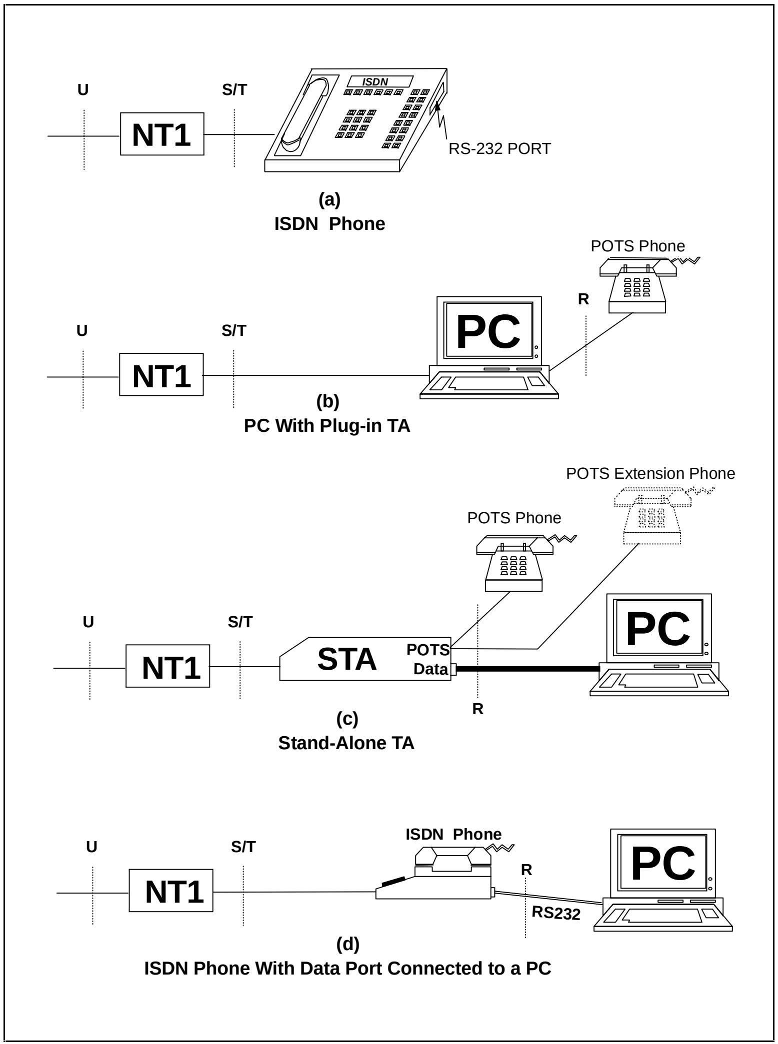

Figure 1-6 Examples of terminal equipment arrangements

1.4.2.6.6 Extension Phones and the R interface

One of the differences between POTS and ISDN is that ISDN does not include the same concept of extension phones as we know in POTS. We cannot just lift the handset of any **ISDN phone** in the building and join in a conversation. A way of providing POTS-like extension capability in an ISDN installation is by using the R interface mentioned in the preceding paragraph. Unfortunately, the R interface is not as well defined as it might be. Characteristics such as the number of POTS extension phones supported by an R interface, the number of ringer equivalencies, and the allowable cabling distances, are left somewhat to the vendor's discretion. Thus, if you need to make use of the R interface and have specific requirements, then check them out with the equipment vendor ahead of time.

1.4.3 Working out a wiring plan

One type of arrangement often used for POTS wiring is to run the wire so that it passes sequentially through each jack location. This is often referred to as a series or **daisy chain** configuration.

While the series, or daisy chain, wiring arrangements described above are acceptable for POTS, they are not consistent with the ISDN technical standards. In some cases, a series type arrangement will work but in most cases it will not. The wiring arrangement recommended by the EIA/TIA wiring standards is a **star**, or home run, configuration where the wiring to any individual piece of terminal equipment comes from a central or home point and goes only to that terminal equipment location.

1.5 Wiring Terminology for Commercial and Multi-tenant Residential Buildings

Figure 1-7 below depicts a typical telecommunications wiring layout for a single, high rise building. Each of the components is discussed in the sections following Figure 1-7.

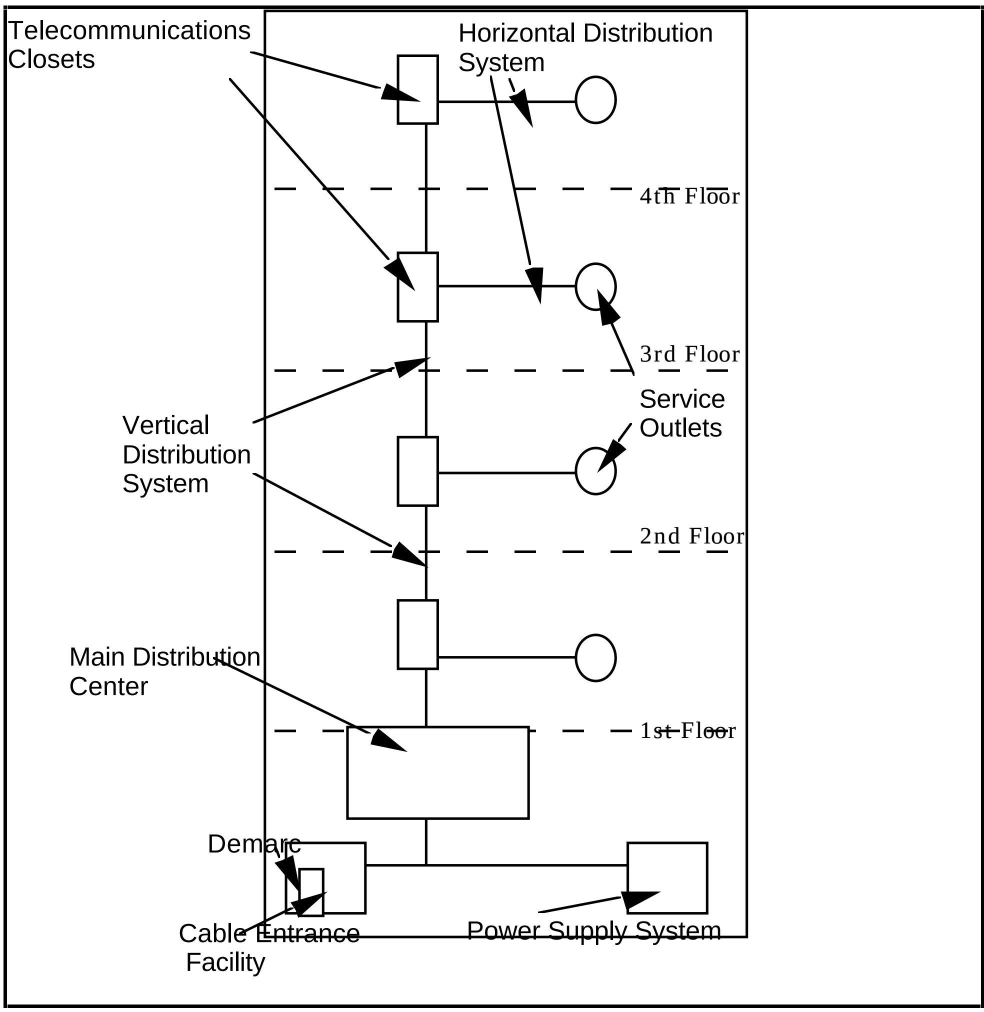

Figure 1-7: Example Wiring Layout for High Rise Building

- **Demarcation Point**

The Demarcation Point (demarc) represents the interface between the service provider's telecommunications network and the network of the building(s). In the case of a campus or multiple building environment, a demarc may serve more than one building.

- **Cable Entrance Facility**

The Cable Entrance Facility is the interface between the outside network (e.g., cable from other buildings in the network, or access line cable) and the internal distribution network of this particular building. The Cable Entrance Facility may contain electrical discharge protection.

- **Main Distribution Center**

The Main Distribution Center or Entrance Room contains telecommunications equipment such as NT1s and telecommunications switches. The cables from the Cable Entrance Facility enter the Main Distribution Center, where they are connected to the telecommunications equipment and the Vertical Distribution System.

- **Vertical Distribution System (Backbone System)**

The Vertical Distribution System, or Backbone Cabling System, consists of the riser cables and structures necessary to connect the cables from the main distribution center to the floors of the building. This system is connected to the horizontal distribution system by cross-connects, which may be contained in the telecommunications closet. For long, low profile buildings, the backbone distribution system may be laid horizontally.

- **Telecommunications Closet**

The Telecommunications Closet (or Intermediate Distribution Center) houses the cross-connect cabling, and/or telecommunications equipment used to connect the vertical distribution system to the horizontal system.

- **Horizontal Distribution System**

The Horizontal Distribution System consists of the cabling, connection devices, and structures necessary to connect the cables from the vertical distribution system to the service outlet at the workstation. The Horizontal Distribution System is also know as homerun cables or station cables.

- **Service Outlet**

The Service Outlet is the interface connecting the cable from the horizontal distribution system to the work area.

- **Work Area**

The Work Area is the room or location that contains the Service Outlet.

- **Power Supply System**

The Power Supply System provides AC power and/or backup power for the telecommunications equipment in the main distribution center.

2. The Demarcation Point

This section describes possible wiring and equipment configurations based on the location of the demarc in the building. After the wiring and equipment alternatives are given, this section points the reader to the applicable text in Sections 3, 4 and 5, which gives details about the wiring and equipment alternatives. This section generally assumes that the service provider's wiring responsibility ends at the demarc, and that the wiring on the customer's side of the demarc is the customer's responsibility. However, this may not always be the case. Check with your service provider to determine where your wiring responsibility begins.

Before requesting ISDN service from you service provider, you should familiarize yourself with the type of connectors that will be used to connect your equipment at the demarc. Once you know the type of connectors that are provided on your ISDN equipment, you can order from your service provider the appropriate type of connection device at the demarc.

There are three connector arrangements that are commonly used for terminating ISDN service at the demarc: 6-position modular jacks (sometimes referred to as RJ-11), 8-position modular jacks (sometimes referred to as RJ-45), and 50-position ribbon connectors (commonly referred to as RJ-21X). Not all connector arrangements are available from every service provider and you should specifically request a connector arrangement when you order ISDN service. Consult your ISDN equipment documentation first, to determine the recommended demarc connector arrangement, then make sure you request the appropriate connector when you order your service.

For example, if you plan to install a single ISDN line, an 8-position modular jack (RJ-45 type) at the demarc may be most appropriate, since you can then connect a standalone NT1 or U interface terminal device directly to the demarc. For multiple line installations, an RJ-21X demarc, which provides termination for up to 25 ISDN lines, might be desired. This demarc arrangement is usually recommended to connect directly to a rack of NT1s or for convenient cross connection to in-house building wiring.

2.1 Demarc in the Cable Entrance Facility

If the demarc is located in the cable entrance facility or equipment room near the cable entrance facility, then vertical cabling will be needed between the demarc and the telecommunications closet that serves the tenant. In addition, horizontal cabling will be needed between the Telecommunications Closet and each work area. Figure 1-7 depicts an example of a high rise building with the demarc in the cable entrance facility. Section 3 provides guidelines for determining if the existing vertical and horizontal cabling can be used for the ISDN service, or if new cabling is required. Section 4 provides standard cabling practices for vertical and horizontal cabling.

With the demarc in this location, there are several choices for the location of the NT1s and powering equipment. The NT1s and powering equipment may be located in the equipment room near the cable entrance facility, in a telecommunications closet that serves the tenant, or at the work area. Section 5 describes all of the NT1 and powering equipment configurations given above.

2.2 Demarc in the Telecommunications Closet

If the demarc is located in the Telecommunications Closet, then horizontal cabling will be needed between the Telecommunications Closet and the work area(s). Section 3 provides guidelines for determining if the existing horizontal cabling can be used for the ISDN service, or if new cabling is required. Section 4 provides standard cabling practices for horizontal cabling.

NT1s and powering equipment in this case can be located either in the Telecommunications Closet or in the work area. Section 5.1.2 describes NT1s in the Telecommunications Closet, and Section 5.1.3 describes NT1s in the work area. Section 5.4 describes the powering arrangements.

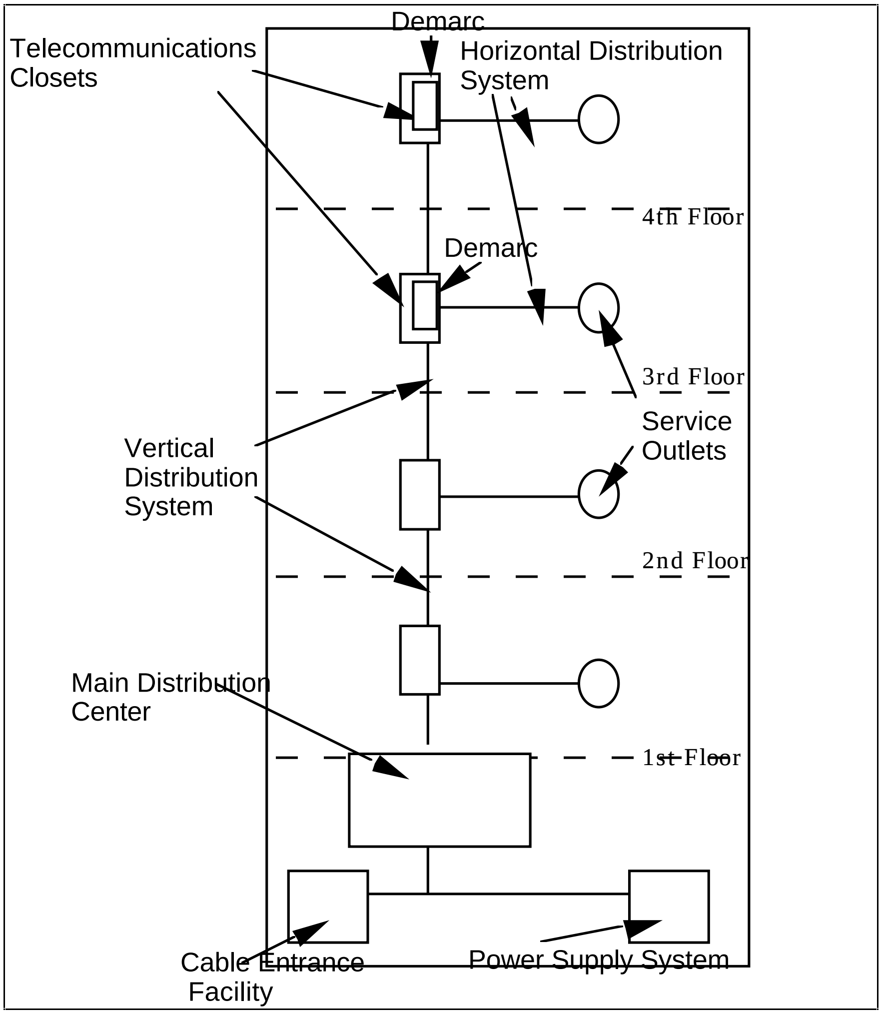

Figure 2-1: Demarc in the Telecommunications Closet

2.3 Demarc in the Tenant Premises

If the Demarc is located within or just outside the tenant's premises (e.g., apartment or suite), then the situation may closely resemble wiring and powering for a small business or home. If this is the case, the reader is referred to the NIUF document NIUF/ICSW/BRI/060, "ISDN Wiring and Powering Guidelines for Residence and Small Business (Version 2)". If the demarc is within the tenant premises, but the premises is very large or consists of several floors, then some sections in this document may be useful. For example, you may need guidelines on wire management and installation if a backbone cabling system will be used to cover the large area or several floors. See Section 5.1.3 for the location of NT1s and wiring configuration

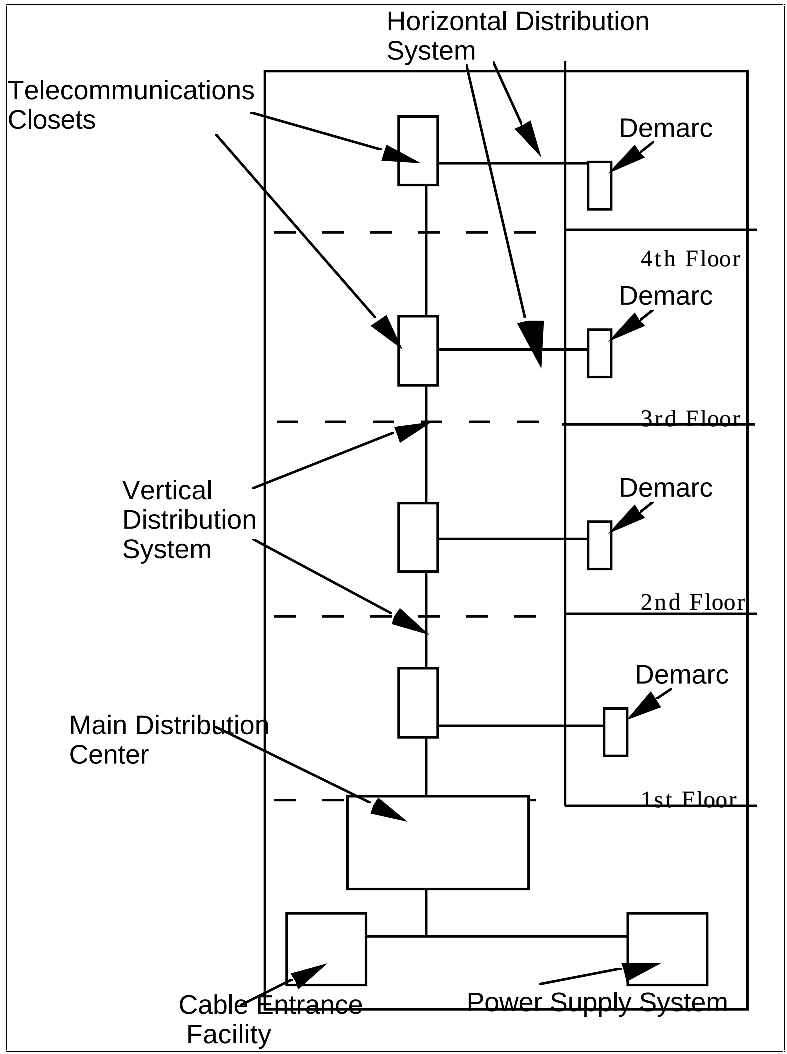

Figure 2-2: Demarc in the Tenant Premises

3. New or Existing Wiring Determination

3.1 Adding ISDN to Current Infrastructure

3.1.1 Limitations of Current Configuration on ISDN

This section contains information on how the current wiring configuration may be adapted to ISDN service. There will be a tradeoff between using existing wiring or using new wiring for an ISDN installation. For new wiring there is time and cost involved with running new wiring. For existing wiring there is time needed to figure out the existing wiring plus any risk that the existing wiring might not be sufficient. If there is any significant uncertainty about the suitability of existing wiring, new wiring is recommended.

There will be several factors that need to be considered to ensure that the ISDN service will operate correctly.

- Determine the grade of wiring that exists in both the horizontal and backbone wiring. For ISDN, it will be necessary to have category 3 or better unshielded twisted pair (UTP) cabling and cross-connect jumpers. If the wiring in the building does not meet these requirements, it will be necessary to run new wiring for the installation.

- Determine how the wire is connected. If the connection is run in series (daisy chain configuration), it will not be appropriate for ISDN. For ISDN wiring, the star, or home run, configuration is recommended.

- Any pairs that were installed for another service and are to be used for ISDN, need to be checked to ensure that these wires are not attached to bridged taps or unused jacks. Removing all extraneous connections from a line that is to be used for ISDN will help to ensure that the line will work correctly.

- Determine the type of ISDN configuration that will be used in the building. In other words, where will the U interface be terminated and the S/T interface begin. This will influence the number of wire pairs that will be needed for each line. It will also affect where the NT1s and power supplies can be located.

- Determine if enough unused spares or pairs that will be transferred to ISDN exist in both the backbone and horizontal distributions. If not, it will become necessary to run new wire.

- Determine whether the existing system will have enough room for expansion. Using existing duct systems that are near capacity may limit future services.

- Determine whether existing system connection equipment, such as distribution devices, are also capable of handling ISDN service. All connectors should also be category 3 or better.

It may also be necessary to replace service outlets. It is recommended that service outlets are 8-pin connectors that are at least equivalent to the quality of the cable that they terminate, which is a minimum of category 3. Further information about acceptable 8-pin connectors can be found in Section 1.4.2.1.

Each ISDN line will require a minimum of 1 pair for the U-interface and 2 to 4 pairs for the S/T interface. Lines that were used for plain old telephone service (POTS) or data services may be re-used for ISDN provided that they meet the requirements mentioned above as well as ISDN distance requirements which will be discussed later.

If the pairs that are going to be used for ISDN are going to share the same cabling with other services, such as high-speed data services, it is important to determine that no spectral interference, such as crosstalk exists that will detriment the quality of the ISDN signal. It may be necessary to conduct a shared sheath analysis or perform a bit error rate test to determine if other services are affecting the ISDN service.

3.2 New Wiring

3.2.1 Pre-wiring Planning

This section contains a set of questions that need to be answered to determine the wiring requirements for a building. Each question contains a discussion of some of the issues that will need to be considered to obtain a reasonable answer to the question. The list of questions and the answers are not exhaustive, but provide an initial guideline for planning an installation.

- Will other telecommunications services be used in addition to ISDN?

Before wiring a new building or re-wiring an existing building, it is critical that the current and future needs of the building be taken into account. The quick growth in data communications will cause changes in the way in which the installed wires are used and in the demand for certain desktop services. Some of the services that may reside with ISDN are voice services (POTS), centrex, premise switching equipment, high bandwidth multi-media applications (asynchronous transfer mode - ATM), and corporate networks (local area networks - LANs). Because telecommunications technology tends to have a fast turnaround time, it will not be possible to fully forecast all of the future needs during this initial phase. Guidelines for future expansion and growth are given in the sections specific to the type of building that is being wired.

Several factors are important in the determination of the wiring that will be required to support telecommunications services.

1. The type of service will affect the number of wires required. This will also determine if any spare pairs or spare bandwidth will exist that can carry additional services in the future.

2. The type of service will affect the type of cabling used. For example, the planner might want to use category 5 UTP for ISDN wiring, instead of category 3 UTP, to enable that wire to be used for other data services in the future.

3. The type of service will affect the possibility of cable replacement in the short term by newer technology.

4. The demand for the service will determine if it will be wired to all work areas or a subset of work areas.

If the pairs that are going to be used for ISDN are going to share the same cabling with other services, such as high-speed data services, it is important to determine that no spectral interference, such as crosstalk exists that will detriment the quality of the ISDN signal. It may be necessary to conduct a shared sheath analysis or perform a bit error rate test to determine if other services are affecting the ISDN service.

- What type of ISDN terminals will be needed?

The type of terminals will depend on the applications that will be used. It may be important to agree on a common set of terminals that will be used for different applications to reduce the number of different wiring configurations. For example, it may be decided to use only U-interface terminal equipment (TE) instead of S/T interface TE. The number of ISDN terminals will impact the number of NT1s required and the amount of power that may be needed.

- Where will the NT1s be located?

Section 5.1 gives alternatives for the placement of NT1s. There are several factors that will decide the location of the NT1s. As discussed in Section 2, one of major driving factors will be where the service provider's responsibility ends. This will determine the first point at which the S/T interface can begin. The number of NT1s and their powering needs will also drive where they will be located. In order to save space and allow for expansion, a rack of NT1s may be more appropriate for some installations than stand-alone NT1s.

- Where will power supplies be located?

Section 5.4 gives guidelines for power considerations. The planner should consider the location of power supplies when planning the location and size of equipment rooms or telecommunications closets, if applicable.

- Where will the demarcation point be located and what connector configuration is provided to the demarcation point?

Section 2 provides information on finding the location of the demarcation point and determining the type of connection that will be necessary to make a connection to the demarcation point.

4. Standard Telecommunications Cabling Practices

There are a number of organizations that develop commercial building wiring standards and guidelines. Some of these include: the Electronic Industries Association/Telecommunications Industries Association (EIA/TIA), Building Industry Consulting Services International (BICSI), and the Federal Communications Commission (FCC). Many of the standards developed by these organizations are generic in nature, and can be applied to many different telecommunications systems. However, these standards are an excellent source of guidance on telecommunications wiring implementations.

This section references the EIA/TIA standards extensively. In particular, this document references EIA/TIA-568 “Commercial Building Telecommunications Cabling Standard”, which describes a generic telecommunications cabling system for commercial buildings that will support a multiproduct, multivendor environment. It is recommended that you adhere to the EIA/TIA standards when wiring for ISDN. In addition, local building, fire, and electrical codes applicable in your area must be followed.

This section also references FCC regulations concerning the placement of the demarc with respect to the building.

A list of references can be found in the References section of this document.

In addition to describing particular standards, this section also recommends some practices that are specific to ISDN that may have been optional or outside the scope of the standards.

4.1 Entrance Facility and Equipment Rooms

The entrance room serves as a connection for outside cabling to internal building cabling. The entrance room may contain telecommunications equipment, protection devices for the outside cable, and connecting hardware to connect the outside cable to the inside cable.

In addition, the entrance room may contain the demarcation point (demarc). The location of the demarc is determined by federal and state regulations. For more information concerning location of and connection to the demarc, see FCC regulations, Section 2, and NIU/ICSW/BRI/060, "ISDN Wiring and Powering Guidelines (Residences and Small Businesses)".

Equipment rooms are different from telecommunications closets because of the nature of the equipment contained in them. Equipment rooms may contain the building's telecommunications equipment, as well as connecting hardware, or splice closures. The equipment room also contains either the main cross-connect or an intermediate cross-connect to the backbone cabling, or even terminations for a portion of the horizontal cabling.

EIA/TIA-568, contains cabling practices for cables that enter or leave the equipment room, and connecting hardware within the equipment room. Particularly, EIA/TIA-568 states that precautions should be taken to avoid cable stress caused by tension in the cables. EIA/TIA-

568 also states that when terminating cables on connecting hardware, unnecessary untwisting of pairs should be avoided by stripping a minimal amount of cable jacket.

EIA/TIA-569 "Commercial Building Standard for Telecommunications Pathways and Spaces" contains standards for the design, location, size and provisioning of the entrance room, related entrance facilities, and equipment rooms.

4.2 Backbone Cabling (Vertical Cabling)

4.2.1 Backbone Cabling Configuration

EIA/TIA-568 states that the backbone cabling shall be a conventional hierarchical star topology as shown in Figure 4-1.

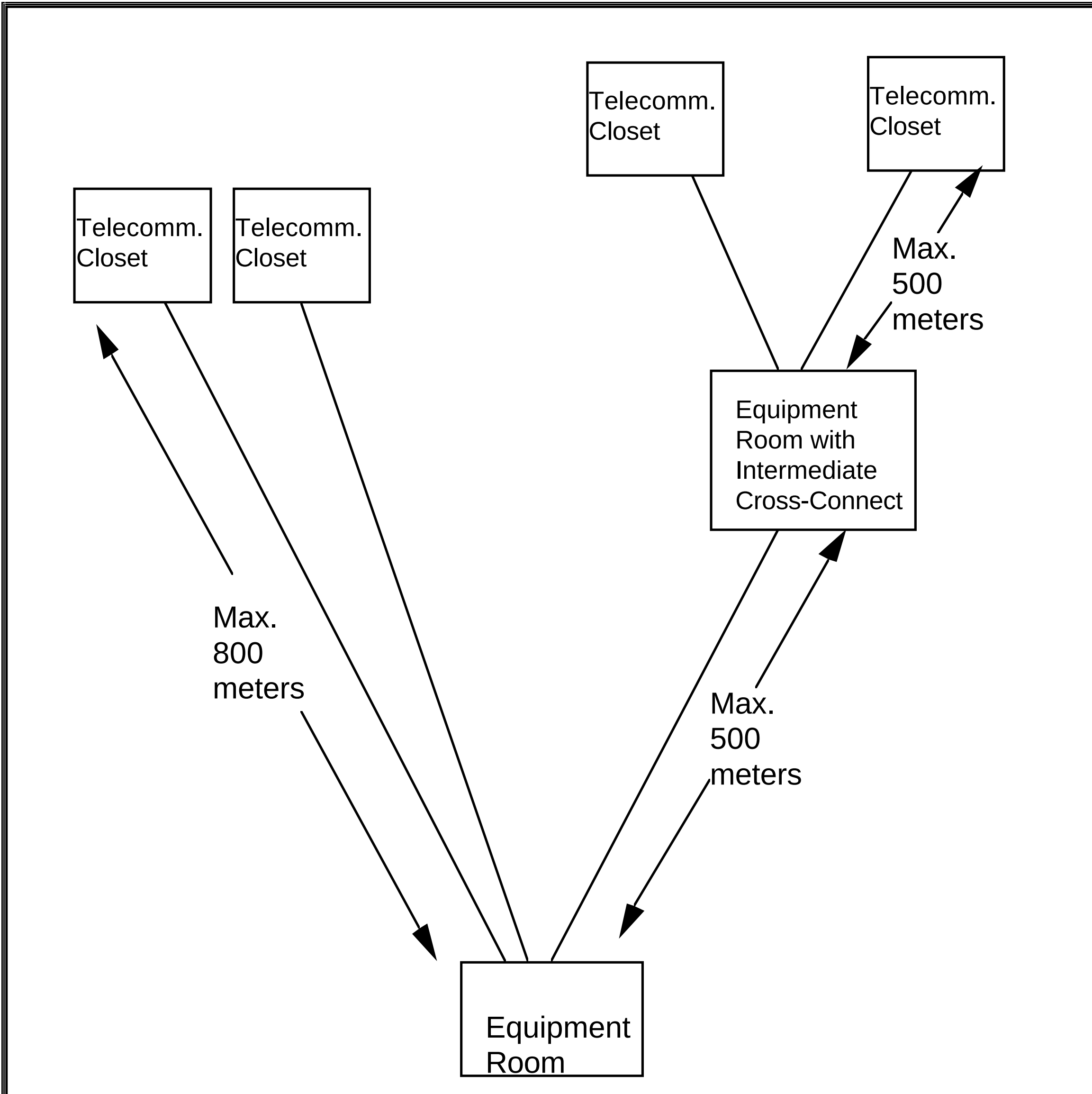

Figure 4-1: Star Topology for Vertical Cabling

4.2.2 Cable Types

Since the EIA-TIA-568 standard was intended to support a range of applications, several types of cable are mentioned for use in the backbone cabling system. These are:

- 100 ohm unshielded twisted-pair (UTP) cables (recommended for ISDN)
- 150 ohm shielded twisted-pair (STP-A) cables (not suitable for ISDN)

- 62.5/125 µm optical fiber cable (not recommended for ISDN)
- single-mode optical fiber cable (not recommended for ISDN).

For ISDN installations, these guidelines recommend that 100 ohm UTP cable, 24-gauge, category 3 or better, be used for the backbone cabling. If optical fiber cable were used, it would be necessary to use electronic equipment to convert between the electrical and optical interfaces.

Because of the characteristics of shielded wire, STP cannot be used with ISDN.

The number of cables to be installed for the backbone cabling depends on several factors. Section 3 provides additional information for determining the amount of cable to install.

4.2.3 Backbone Cable Distances

EIA/TIA-568 gives backbone cabling distances for several configurations. In general, the maximum cable distance for UTP cable between the main cross-connect and the horizontal cross-connect (if no intermediate cross-connects are used) is 800 meters (2625 ft.). If an intermediate cross-connect is used, then the maximum distance between the main cross-connect and the intermediate cross-connect is 500 meters (1640 ft.), and the maximum distance between the intermediate cross-connect and the horizontal cross-connect is 500 meters. Figure 4-1 shows these distances.

If the backbone cabling carries the S/T interface, then further distance limitations will apply. See Section 5 for this case.

4.2.4 General Backbone Cabling Installation Practices

4.2.4.1 Electromagnetic Interference (EMI), Building, Fire and Electric Codes

Consideration should be given to the proximity of backbone cabling to sources of electromagnetic interference (EMI). EIA/TIA-569, contains additional information concerning the separation of backbone cabling from sources of EMI. In addition, Table 4-1 gives guidelines for the separation of UTP cable from sources of EMI.

Conditions	Minimum Separation Distance		
	<2 kVA	2-5 kVA	>5 kVA
Unshielded power lines or electrical equipment in proximity to open or non-metal pathways	127 mm (5 in.)	305 mm (12 in.)	610 mm (24 in.)
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway	64 mm (2.5 in.)	152 mm (6 in.)	305 mm (12 in.)
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway	-	76 mm (3 in.)	152 mm (6 in.)
Transformers and electrical motors	1016 mm (40 in.)		
Fluorescent lighting	305 mm (12 in.)		

Table 4-1 UTP Separation Distances from EMI Sources 480 V or Less

Building, Fire and Electric codes may contain guidelines and requirements for the installations of inside wiring. Be sure to consult these codes.

4.2.4.2 Backbone Cabling Systems

In addition to EMI concerns regarding the placement of telecommunications cabling close to any power lines or equipment, another concern is accidental contact with power lines or equipment by telecommunications personnel during cable maintenance or installation. For these reasons, be sure to consider telecommunications cabling placement with respect to power lines and equipment.

Another utility to consider when installing backbone cabling (or any other telecommunications cabling) is water pipes. Steam pipes can melt cable sheaths and damage the cable. Floods can result in moisture inside the cable, which can alter its electrical characteristics.

Backbone cable that is installed vertically must be secured both at the highest point of the cable run and intermediate points (e.g., telecommunications closets). Therefore, hardware used to support vertical cable should be stress tested to ensure that they can support the cable weight at maximum capacity.

The installer (or planner) should be sure that the backbone system hardware provides adequate access to backbone cabling, perhaps at telecommunications closets locations, to simplify the cable installation, and to facilitate troubleshooting.

Since backbone systems typically carry many cables, you may want to label individual cables or group of cables not only for proper wire management, but also to make it easier to locate particular cables at a later date. See Appendix A for additional information regarding wire management.

Finally, if the backbone cable will be carrying other services in addition to ISDN, then see Section 3 for service interaction considerations.

4.2.4.3 Grounding Considerations

Grounding systems are necessary to protect personnel and equipment from hazardous voltages. In addition, they may reduce EMI to and from the telecommunications cabling system. The applicable authorities or codes should be consulted for grounding requirements and practices. EIA/TIA-607, "Grounding and Bonding Requirements for Telecommunications in Commercial Buildings", contains requirements for telecommunications grounding.

4.3 Telecommunications Closet

Telecommunications closets may serve many purposes. They are used to connect the horizontal cabling to the backbone cabling, and/or to connect different portions of the backbone cabling. In addition, telecommunications closets house the connecting hardware as well as other telecommunications equipment.

There are several common cross-connect systems used for ISDN in telecommunications closets. 66-blocks and 110-blocks are examples of common cross-connect systems. In addition to the punch down method of connecting cross-connect cables, some cross-connect systems are available with modular connections using 6 position and 8 position jacks, and their associated patch cords. Section 1.4 provides definitions of several types of connectors. Appendix A provides guidelines for wire management in the telecommunications closet to ensure that the cables are easy to locate, neatly configured, and securely fastened to prevent injury to personnel.

EIA/TIA-569 contains standards for the design, location, size, provisioning, and environment of telecommunications closets.

4.4 Horizontal Cabling

4.4.1 Horizontal Cabling Configuration

EIA/TIA-568 states that the horizontal cabling shall be a star topology (home run), and that the horizontal distribution cable should be dedicated to a single service.

4.4.2 Cable Types

Since the EIA-TIA-568 standard was intended to support a range of applications, several types of cable are mentioned for use in the horizontal cabling system. These are:

- four-pair 100 ohm unshielded twisted-pair (UTP) cables (recommended for ISDN)
- two-pair 150 ohm shielded twisted-pair (STP-A) cables (not suitable for ISDN)
- two-fiber, 62.5/125 µm optical fiber cable (not recommended for ISDN)

For ISDN installations, these guidelines recommend that 100 ohm UTP cable, 24-gauge, category 3 or better, be used for the backbone cabling. If optical fiber cable were used, it would be necessary to use electronic equipment to convert between the electrical and optical interfaces.

Because of the characteristics of shielded wire, STP cannot be used with ISDN.

4.4.3 Horizontal Distances

EIA/TIA-568 states that the horizontal distance (from the cross-connect in the telecommunications closet to the service outlet in the work area) shall not exceed 90 meters (295 ft.).

For ISDN, if the NT1s will be located in the Telecommunications closet, then this implies that the cable from the NT1 to the service outlet should not exceed 90 meters. If the NT1s are located in an Equipment room, then the distance from the NT1 to the service outlet should not exceed 90 meters (see Section 5.1.1). If the NT1s are located in the work areas, then the cable length from the telecommunications closet to the service outlet in the work area should not exceed 90 meters. Note that these distances assume 24-gauge, category 3 or better UTP cable.

If patch cords are to be used to connect the horizontal cabling to the backbone cabling, EIA/TIA-568 states that the patch cords shall not exceed 6 meters (20 ft.). The patch cords should be the same category or higher than the cabling.

4.4.4 General Horizontal Cabling Installation Practices

4.4.4.1 Cable Conduit Systems

Several types of conduit systems for horizontal cables are discussed in Appendix A, including ceiling, floor and raceway systems. For new buildings, these conduit systems should not be installed until the building exterior has been completed, to reduce the risk of damage due to adverse weather.

The installer (or planner) should be sure that the conduit system provides adequate access to telecommunications closets locations to simplify the cable installation.

After the conduit system has been installed, any rough edges should be removed to prevent cutting the cables once they are installed within the conduit. In addition, the conduits should be labeled to distinguish them from other distribution systems.

Finally, conduits should be stress tested to ensure that they can support the cable weight at maximum capacity.

4.4.4.2 Electromagnetic Interference (EMI), Building, Fire and Electric Codes

Consideration should be given to the proximity of horizontal cabling to sources of electromagnetic interference (EMI). EIA/TIA-569 contains additional information concerning the separation of horizontal cabling from sources of EMI. In addition, Table 4-1 gives guidelines for the separation of UTP cable from sources of EMI.

Building, Fire and Electric codes may contain guidelines and requirements for the installations of inside wiring. Be sure to consult these codes.

4.4.4.3 Grounding Considerations

Grounding systems are necessary to protect personnel and equipment from hazardous voltages. In addition, they may reduce EMI to and from the telecommunications cabling system. The applicable authorities or codes should be consulted for grounding requirements and practices. EIA/TIA-607 contains requirements for telecommunications grounding.

4.4.4.4 Horizontal Cabling for Service Outlets

EIA/TIA-568 requires that there be a minimum of two telecommunications service outlets for each individual work area. For the first service outlet, EIA/TIA-568 requires that four-pair 100 ohm UTP cable, category 3 or higher, be used. For the second service outlet, EIA/TIA-568 gives a choice of either four-pair 100 ohm UTP cable (category 5 recommended), two-pair 150 ohm STP-A cable, or two-fiber 62.5/125 um optical fiber be used.

For ISDN applications, these guidelines recommend that the second service outlet be wired with four-pair 100 ohm UTP cable. Category 5 cable may be used, however, category 3 cable is sufficient for ISDN.

All service outlets should be terminated as 568A or 568B. Be sure to be consistent across all service outlets.

4.5 Work Area Cabling

Work area cabling consists of the cabling between the service outlet and the ISDN Terminal Equipment. See Section 5.1.3 for guidelines on wiring ISDN Equipment to the service outlet.

5. ISDN Equipment and Powering Configurations

This section provides guidelines for ISDN specific wiring and powering considerations such as the placement of NT1s and powering equipment, and point to point and multipoint configurations in the work area. Sections 5.1 and 5.3 deal with wiring issues. Section 5.2 discusses issues dealing with the setup and configuration of the terminal equipment. Section 5.4 contains guidelines on powering and backup power.

5.1 Layout Configurations

Several layout configurations are possible in the types of buildings that this document covers. Each configuration has advantages and disadvantages. The possible configurations will depend on several factors. One factor is where the demarcation point will be located. This will limit, but not necessarily determine, where the power supplies and NT1s may reside. For the purpose of this section, the term equipment room encompasses the main cross-connect and any intermediate cross-connects. The term telecommunications closet encompasses both the horizontal cross-connect and any satellite closets.

5.1.1 NT1s in the Equipment Room

A rack of NT1s or stand-alone NT1s can be placed in the Equipment Room. In this configuration, the U-interface will terminate on the NT1 and the S/T interface will be run up the riser to the cross-connect and along the horizontal distribution to a service outlet. Figure 5-1 contains an example of this configuration wiring a single ISDN terminal.

NOTE: In this configuration, distance considerations may affect the termination method that must be used for the S/T interface. See Section 5.2 for more details.

NOTE: This configuration requires that 2 to 4 pairs be run up the riser for each S/T line rather than 1 pair for a U-interface line. Thus, it may not be cost effective to use this configuration if the number of pairs in the riser are scarce.

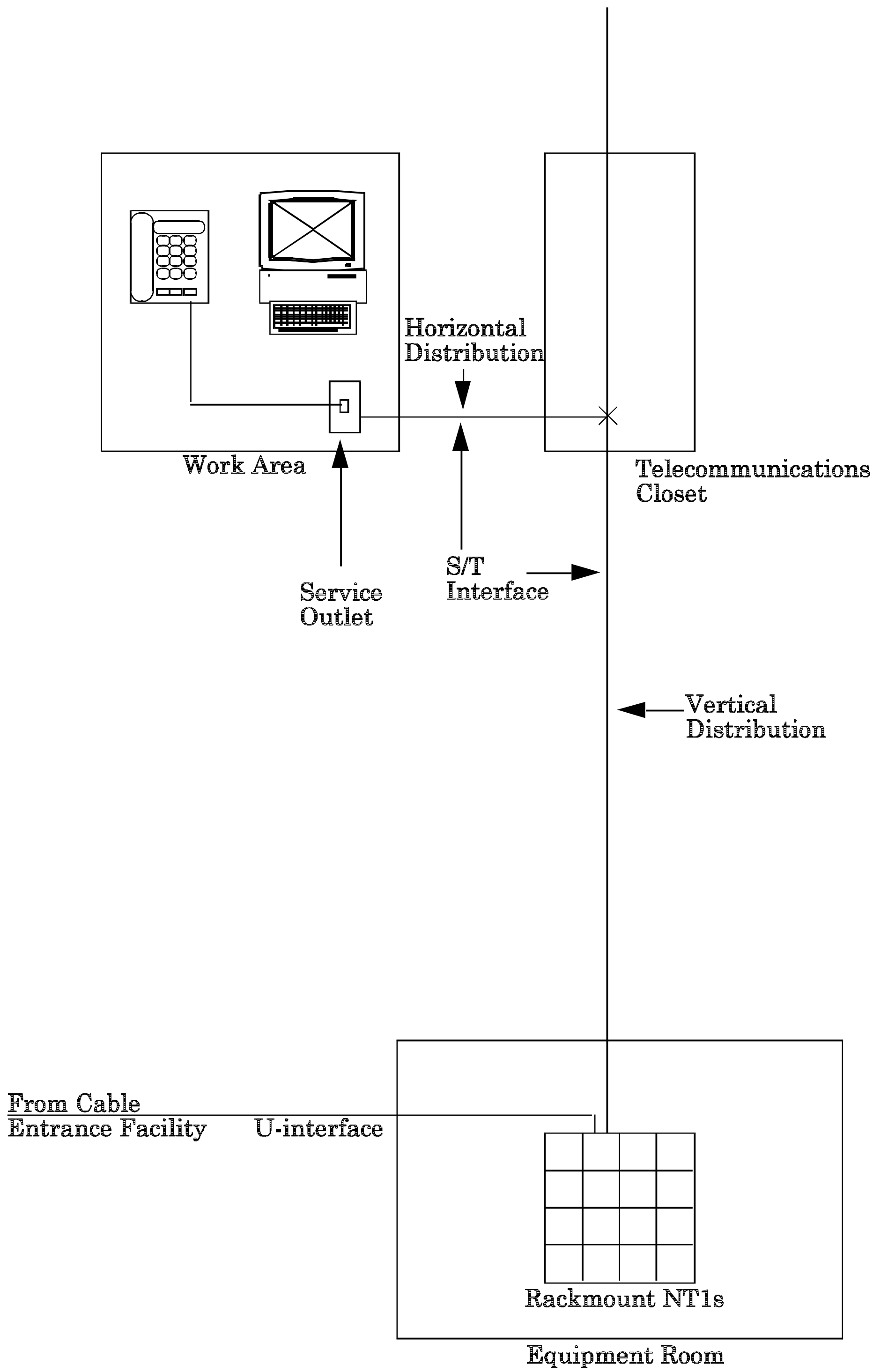

Figure 5-1 - NT1s in the Equipment Room

5.1.2 NT1s in the Telecommunications Closet

A rack of NT1s or stand-alone NT1s can be placed in the Telecommunications closet. In this configuration, the U-interface is extended from the cable entrance facility to the cross-connect. The NT1 will terminate the U-interface and an S/T interface will be run from the NT1 to at least one service outlet in the work area. Figure 5-2 contains an example of this configuration wiring a single ISDN terminal.

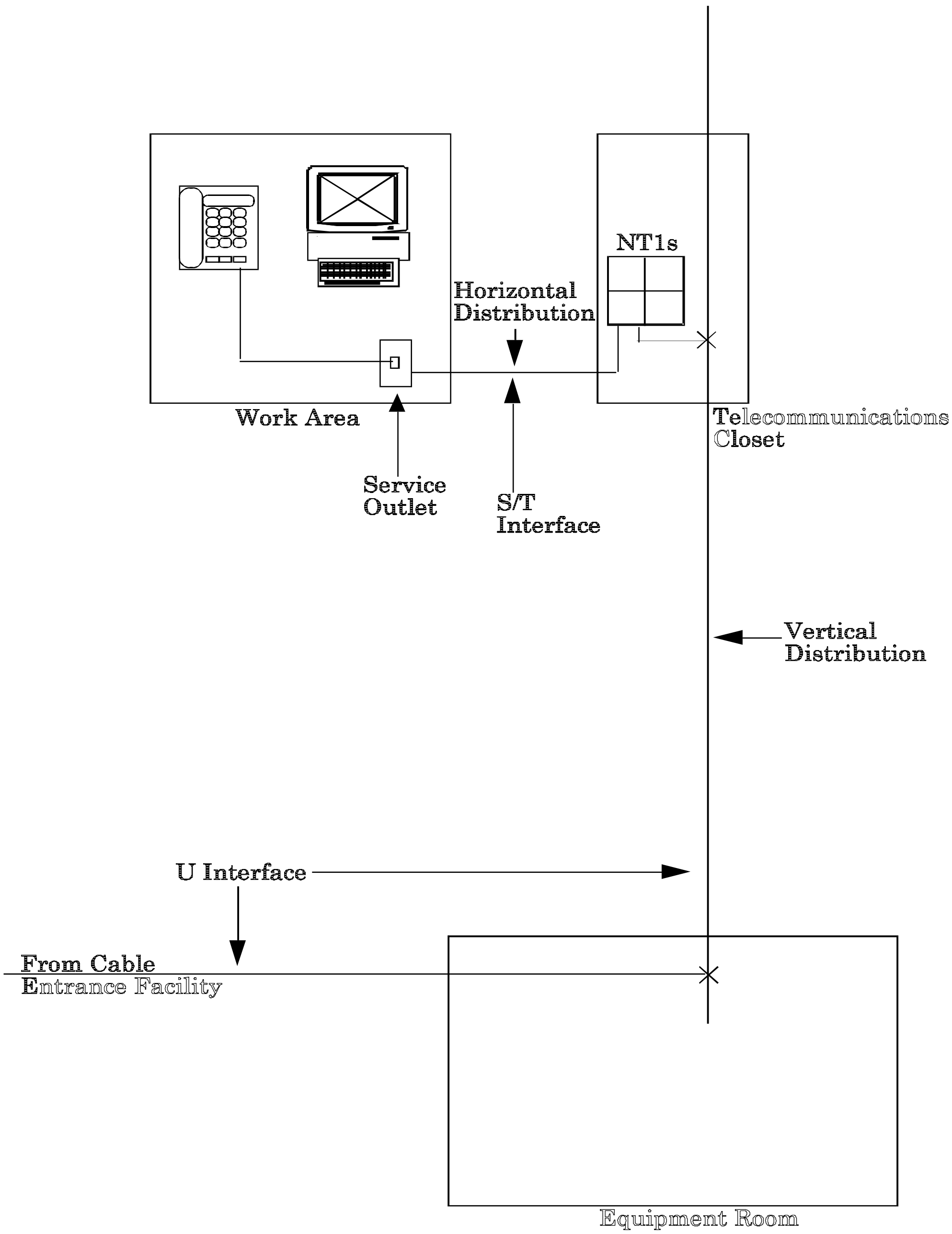

Figure 5-2 - NT1s in the Telecommunications Closet

5.1.3 NT1s in the Work Area

In this configuration, the U-interface is run up the riser and along the horizontal distribution to be terminated at the work area by a stand-alone NT1 or U-interface TE. Figure 5-3 contains an example of this configuration wiring a single ISDN terminal.

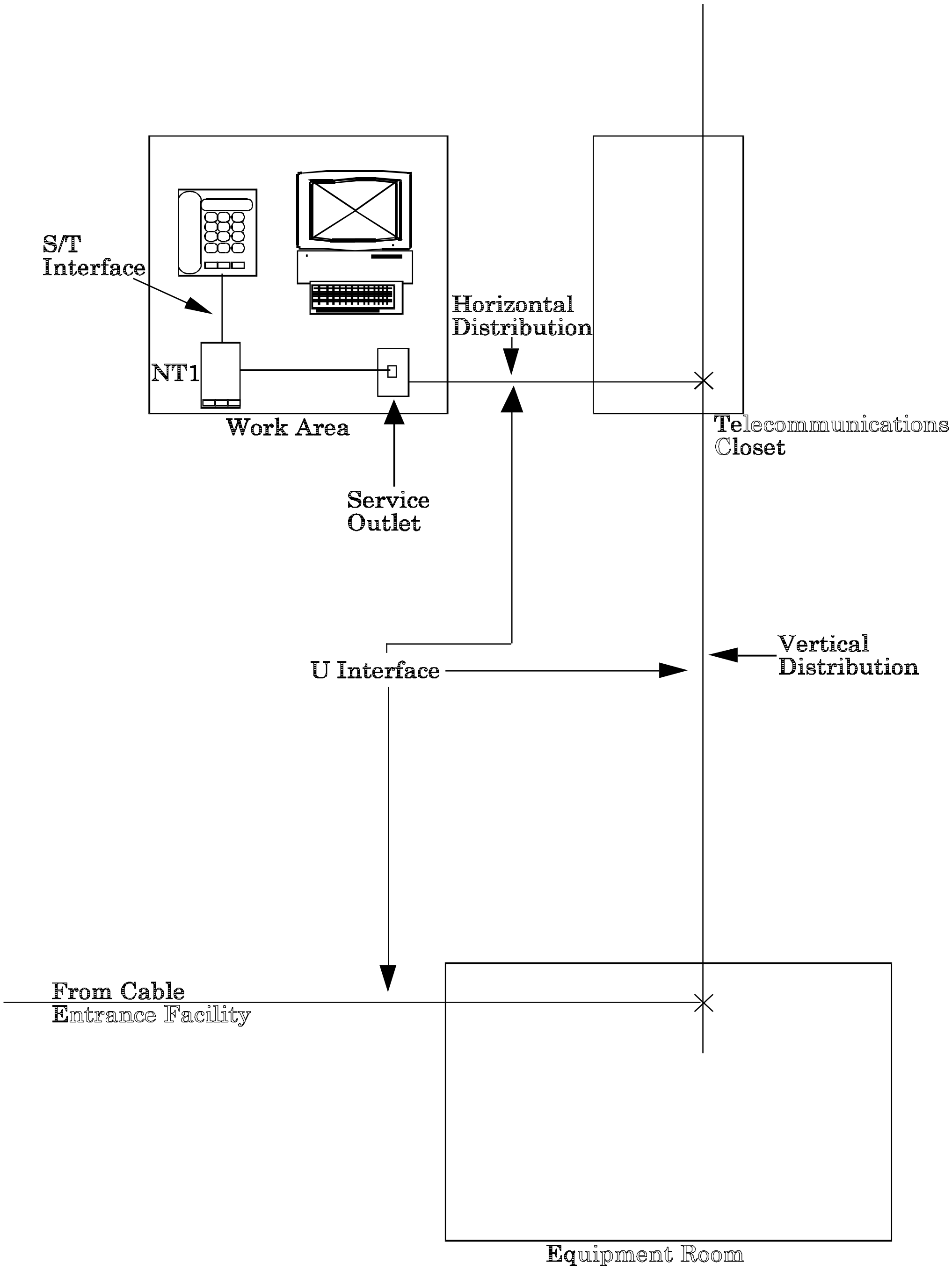

Figure 5-3 - NT1s in the Work Area

5.2 Work Area Considerations

The work area is the fundamental building block of the wiring system. This is where the final application will reside that will benefit from the wiring and powering considerations discussed in this document.

For many applications, S/T interfaces should not be wired between work areas to reduce contention for the ISDN resources, reduce physical complications of distance and termination, and enable future expansion of work area ISDN demand. In this case, each work area would have its own dedicated ISDN line. If it is desired to share ISDN capabilities between multiple work areas, these work areas should be physically located near each other.

A service outlet at a given work area may be wired in several configurations. These configurations depend on several factors, such as whether the service outlet provides a U-interface or an S/T interface. It is recommended that all work areas be set up in one standard configuration. This will help to ensure that all work areas will have a common interface and may help to reduce problems and confusion. However, it may be necessary to support different types of ISDN TE, which may require that several ISDN configurations co-exist within the same building. Thus, it will be important to determine the current configuration of the ISDN line that is connected to the work area to determine whether a unit can physically interface to that jack. Labeling of outlets is one way to ensure that the terminal used is compatible with the configuration.

The following is a list of possible configurations that may be used for the service outlet. The list focuses on the ISDN interface point, termination needs, multi-point or point-to-point. The interface point refers to U interface versus S/T interface. Termination needs refer to whether the TE requires a termination resistance separate from the wiring to match impedance with the NT1. Point-to-point and multi-point refer to whether the interface is reserved for a single TE device or multiple TE devices can share the interface.

- U-interface configuration, point-to-point, termination internal to unit
- S/T interface configuration, multi-point, termination required
- S/T interface configuration, multi-point, termination not required
- S/T interface configuration, point-to-point, termination required
- S/T interface configuration, point-to-point, termination not required

The type of power source, which will be further described in Section 5.4, that is being used to transport power to the TE may also cause configuration and compatibility problems. Each section will detail how ISDN equipment may be attached to the wall for the different configurations.

This section provides information on the distance limitations that need to be considered when wiring ISDN. All distances that are given assume that the cabling being used is a minimum of 24-gauge, category 3 UTP.

5.2.1 Point-to-Point S/T Configurations

In the point-to-point configuration, a work area contains its own dedicated ISDN line. The work area uses a single ISDN BRI TE device to terminate the S/T line. Configurations where multiple devices are connected to a single ISDN line are given in Section 5.2.2.

This subsection relies on a configuration where the NT1s reside in either the Equipment Room or Telecommunications Closet as described in Section 5.1. Therefore, the jack in the work area should be an 8-position jack that is supported by a 100 Ω UTP cable that has at least two reserved pairs - transmit and receive. Note that a third pair will be required for configurations where power will be provided from a remote location, such as the equipment room.

The distance of the cord from the 8-position jack to the TE plus any cross-connect jumpers and patch cords shall not exceed 33 ft (10 m). It is, therefore, recommended to limit the cord from the outlet to the TE to 9.8 ft (3 m). It is expected that the cord used to connect the TE to the jack will conform to ANSI T1.605, “Integrated Services Digital Network (ISDN) - Basic Access Interface for S and T Reference Points (Layer 1 Specification)”. For the cord to meet the ANSI standards, it will need to be unshielded twisted pair (silver-satin cable will not be sufficient).

The NT1 should be configured to be terminated with 100 ohms. If the NT1 has an option for timing, refer to the NT1 manufacturer's manual for recommended settings. The manual should also contain information on how the termination on the NT1 can be configured.

If the TE has an internal termination option, set it to 100 ohms. Refer to your TE manual for details on termination configurations and instructions. If the TE does not provide internal termination, it is possible to provide an external termination device between the TE and the wall jack. This is the recommended configuration because it permits at least 1,900 ft (580 m) of distance between the TE and the NT1 using category 3 UTP. Note that although the EIA/TIA standards limit horizontal cabling distances to 295 ft (90 m) and distances from the main cross-connect to the horizontal cross-connect to 2,625 ft (800 m), the total point-to-point cable length must be less than 1,900 ft (580 m). Figure 5-4 gives an example of this configuration.

Note that if no termination is used at the TE and the NT1 is configured to be terminated to 50 ohms, then the TE can reside no further than 295 ft (90 m) from the NT1.

NOTE: If there are problems with the connection, make sure that the S/T interface is properly terminated, recommended cable lengths are not exceeded, and there are no bridged connections on the point-to-point cable run.

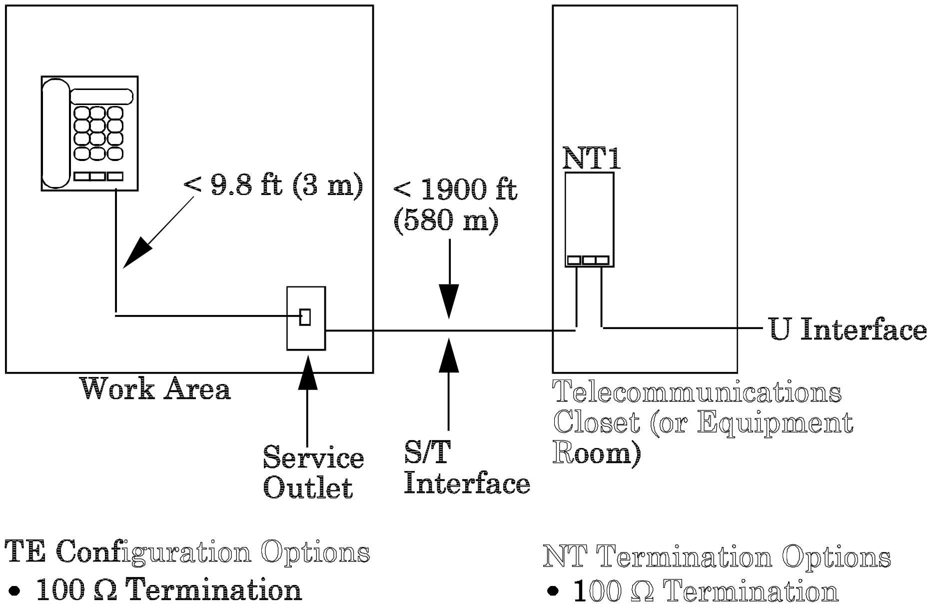

Figure 5-4 - Standard Point-to-Point S/T Interface Configuration

5.2.2 Multiple Desktop ISDN Applications

A user may have several ISDN applications on their desktop. As mentioned earlier, the standard work area will be equipped with two jacks - one for voice applications and one for data applications. It might be possible that both of these lines are used by ISDN applications. If each line is used by a separate TE device, then each line should be configured as a point-to-point connection as described in Section 5.2.1. However, the S/T interface allows multiple TE devices to share ISDN resources. An example of this would be an ISDN phone unit sharing the S/T interface with a PC card that supports desktop video conferencing over ISDN.

In this scenario, it is recommended that a distribution device, such as a bridging adapter or modular jack adapter, be used in the 8-position wall jack. The modular jack adapter contains an 8-position plug that directly connects to the wall jack and distributes the four pairs to several (2 to 8) 8-position jacks. The bridging adapter is a similar device, except that it requires a cable to attach the bridging adapter to the service outlet. It is recommended that the NT1 be terminated with 100 ohms and that the other 100 ohm termination reside externally at the adapter. If the NT1 has an option for timing, refer to the NT1 manufacturer's manual for recommended settings. The manual should also contain information on how the termination on the NT1 can be configured.

NOTE: Not all central office switches will support more than two units on an S/T bus. Consult your service provider for information on the switch serving your area if more than two TE devices will be used on a single S/T interface.

The distance of the cord from the distribution device to the TE plus any cross-connect jumpers and patch cords shall not exceed 33 ft (10 m). It is, therefore, recommended to limit the cord from the adapter to each desktop application, i.e., telephone and PC Card, to 9.8 ft (3 m).

Each cable that is used to connect the TE to the jack shall conform to ANSI T1.605. For the cord to meet the ANSI standards, it will need to be unshielded twisted pair (silver-satin cable will not be sufficient).

The internal terminations of the TE should be disabled. Running under this scenario, the recommended maximum distance from the NT1 to the jack using 24 gauge category 3 UTP cabling and the termination scenario described above is 1,148 ft (350 m). This configuration permits a maximum of four terminals to be connected to the distribution device. Note that although this configuration can handle distances of up to 1,148 ft (350 m), the EIA/TIA standards limit horizontal cabling distances to 295 ft (90 m). Figure 5-5 shows an example of this configuration.

Note that if no termination is used at the wall jack, the TE is unterminated, and the NT1 is configured to be terminated to 50 ohms, then the NT1 can reside no further than 295 ft (90 m) from the wall jack.

NOTE: If there are problems with the connection, make sure that the S/T interface is properly terminated, recommended cable lengths are not exceeded, and there are no bridged connections on the cable run.

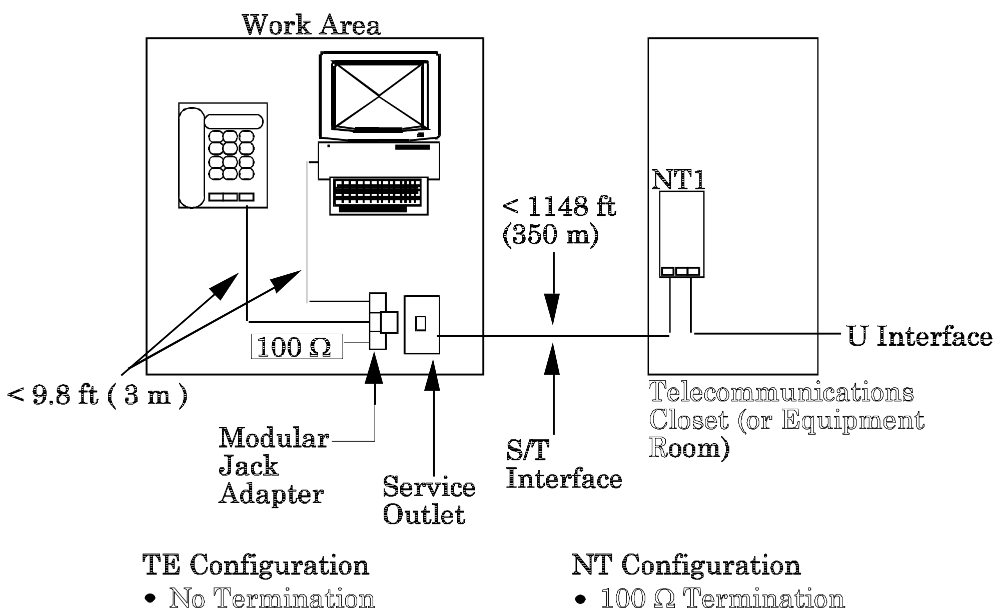

Figure 5-5 - Standard Multi-point S/T Interface Configuration

5.2.3 Multiple Applications Shared Across Work Areas

Some applications may benefit from sharing ISDN resources across different work areas. An example of this would be Point-of-Sale (POS) applications that share the bandwidth of an ISDN line. In this configuration, the location of the NT1s will depend on where the units that will share the S/T interface reside.

If all of the outlets that will terminate the ISDN S/T interface reside on the same floor, the NT1 can reside either in the telecommunications closet or the equipment room. The NT1 will terminate the U-interface. It will be configured to be terminated at 50 ohms on the S/T interface. If the NT1 has an option for fixed or adaptive timing, refer to the NT1 manufacturer's manual for recommended settings. The manual should also contain information on how the termination on the NT1 can be configured. For this configuration, the internal terminations of all the TE should be disabled.

If all of the outlets that will terminate the ISDN S/T interface do not reside on the same floor, the NT1 can reside in the telecommunications closet or the equipment room. The NT1 will be configured as in the above paragraph. However, distance and wiring concerns may be more critical. The S/T interface will be limited in distance by the considerations given later in this section. If the NT1 resides in a telecommunications closet, extra pairs will be needed in the riser in order to run the S/T interface (2 to 4 pairs) to other floors than the one on which the NT1 resides. This may cause problems with wire availability in the riser.

A distribution device must be collocated within 10 ft of the NT1. From the distribution device, a direct connection should be made to each outlet that will share the S/T interface.

The outlet must be an 8-position jack and the TE should not be terminated. The maximum distance from the distribution device to the furthest outlet is 295 ft (90 m).

The distance of the cord from the 8-position jack to the TE plus any cross-connect jumpers and patch cords shall not exceed 33 ft (10 m). It is, therefore, recommended to limit the cord from the outlet to the TE to 9.8 ft (3 m). It is expected that the cord used to connect the TE to the jack will conform to ANSI T1.605. For the cord to meet the ANSI standards, it will need to be unshielded twisted pair (silver-satin cable will not be sufficient). Figure 5-6 shows an example of this configuration.

It is recommended that the outlet be labeled to inform the user that the S/T interface is shared. Thus, TE and applications that are meant to be point-to-point will not be inadvertently attached to the multi-point configuration.

NOTE: If there are problems with the connection, make sure that the S/T interface is properly terminated and that the distances do not exceed those recommended in this section.

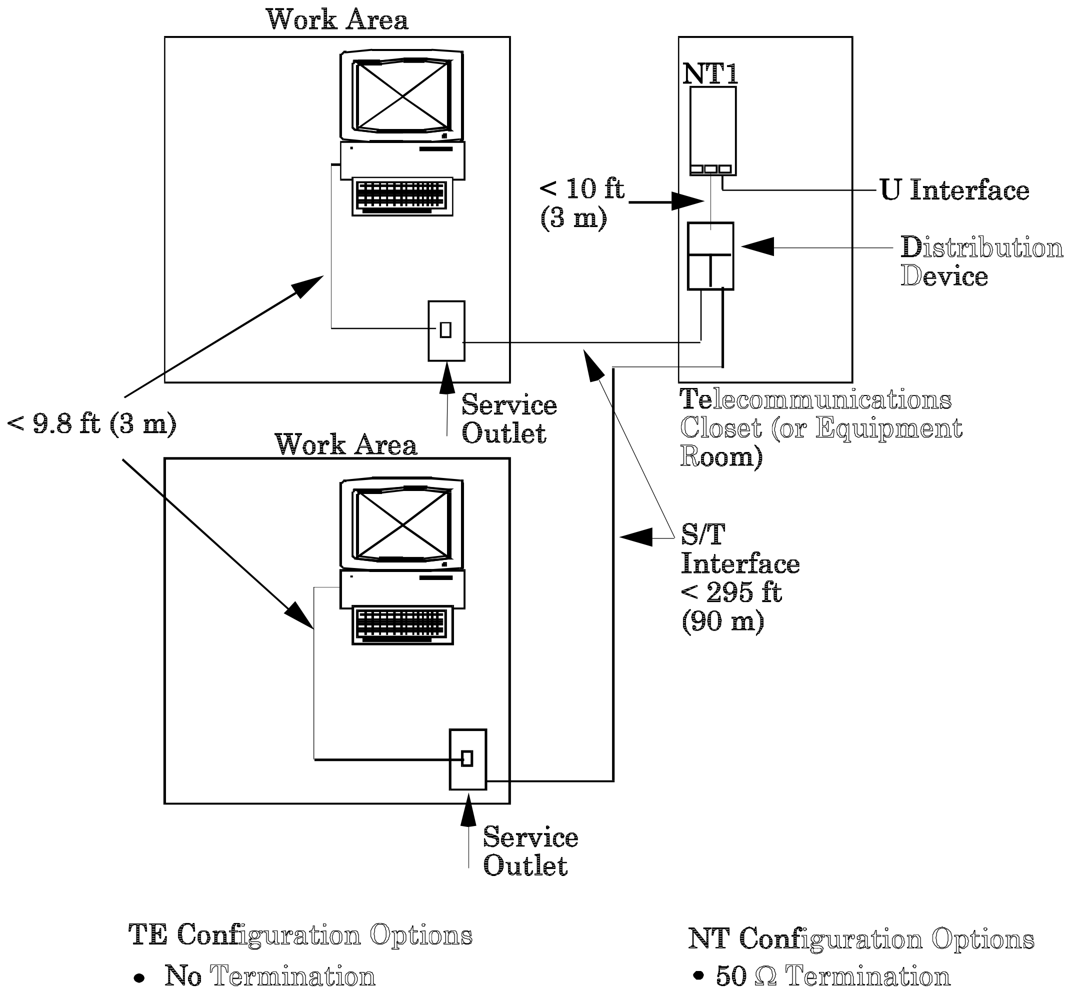

Figure 5-8 - Standard Multi-point S/T Interface Configuration for Multiple Work Areas

5.2.4 U-interface ISDN Equipment

The U-interface configuration can be used for U-interface TE or for the NT1 in the work area scenario described in Section 5.1.3.

Lines that are used for the U-interface must run directly from the equipment room to the service outlet. No other outlets or cable stubs should be connected to the line using distribution devices. If power is provided remotely (i.e., from the equipment room), an 8-position jack with 568A or 568B wiring is required. If the NT1 or U-interface TE are locally powered, only one cable pair is required. As standard practice, it is recommended that an 8-position jack be used and that a 8-position plug be used to attach to the NT1 or U-interface TE. However, either a 6-position plug or an 8-position plug can be attached directly to the 8-position jack. Figure 5-7 has examples of U-interface configurations.

Note that the U-interface may only be configured in a point-to-point environment. It may be possible that a U-interface TE will have S/T ports to allow normal S/T units to share the line with it. In this case, refer to the TE supplier manual for proper distance and termination considerations between the U-interface TE and any additional S/T interface units. It is also possible to configure a point-to-point or multi-point setup if the NT1 resides in the work area. In this case, the terminal(s) and NT1 should be configured as described in sections 5.2.1 and 5.2.2. Termination resistors are not to be connected to the U-interface at any point.

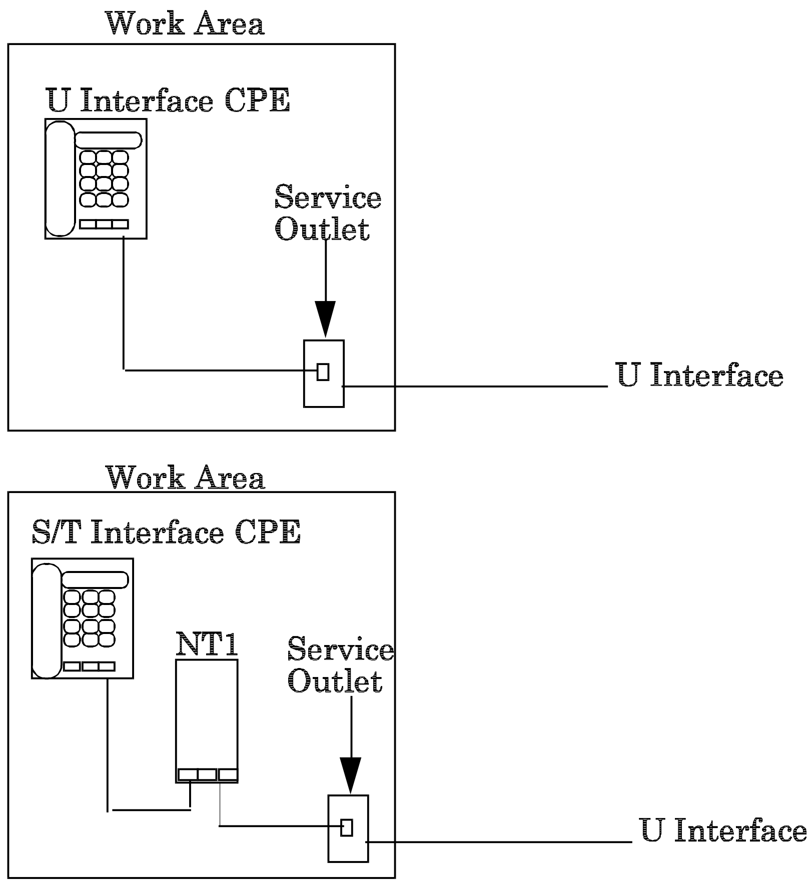

Figure 5-7 - Standard U Interface Configuration

5.3 Wiring for Internetworking Equipment

Several devices may exist, including TE, that provide an interface between ISDN and other services - i.e., POTS, LANs, PCS, and Broadband services.

A list of possible interactions is given below:

- Protocol converter equipment in the telecommunications closet. Example: ISDN access to corporate networks
- Active adapter in the work area to connect ISDN equipment to non-ISDN service available at wall jack. Example: Multiplexing ISDN into Broadband services

- Active adapter in the work area to connect non-ISDN equipment to ISDN service available at wall jack. Example: R-interface terminal adapter connected to a POTS device
- On-premises switching equipment located in the equipment room. Example: BRI PBX to proprietary digital network

Many of these devices are best equipped to reside in the telecommunications closet or equipment room, where they can be provided with power and be administered correctly.

The layout of the wiring, if any, on the customer side of these types of units is beyond the scope of this document. Such a system usually has requirements that are specific to the unit that is being installed. For more information on these specifics, consult the literature from the manufacturer of the equipment.

Any of the units or adapters listed above will be required to be properly configured and terminated on the ISDN side of the interface as described in Sections 5.2.1, 5.2.2, and 5.2.3.

5.4 ISDN Powering Considerations

This section describes powering considerations for ISDN equipment in commercial and multi-tenant residential buildings. Section 5.4.1 provides background material on the powering options for the S/T and U interface. Section 5.4.2 describes several configurations for powering equipment. Section 5.4.3 gives guidelines on the location of powering equipment, and Section 5.4.4 provides guidelines on determining the required size of the power source and backup power supply.

5.4.1 Powering Options for ISDN Equipment

ISDN equipment has different powering requirements than traditional POTS equipment. With POTS, the service provider provides limited power to the customer's equipment. With ISDN, the service provider does not provide the supporting power. However, powering for ISDN equipment is similar to some types of POTS equipment.

POTS equipment can be divided into two categories: basic telephone and High Tech equipment. The basic POTS telephone requires no power when in stand-by mode (on-hook), and very little power when in normal operation (off-hook).

High Tech POTS equipment requires more power than the service provider can provide. Examples of this category of equipment include cordless telephones, fax machines, computer modems, feature phones, speaker phones, and answering machines. This equipment is typically powered from an electrical outlet.

WARNING: Loss of commercial power will require the use of backup power to maintain ISDN service.

In a typical ISDN system of components, the service from the service provider is a single pair U interface which enters the customer location through the demarc. The demarc is then connected to the NT1. Here it is transformed into a 4 pair S/T interface (2 signal, 1 power, and 1 spare).

5.4.1.1 Powering Options for the S/T interface

ISDN powering standards define three different powering options on the S/T Interface. These are called PS1, PS2, and PS3. Consult the manufacturer's equipment manual for the powering option the selected equipment is using. It is recommended that 4 pair (8 wire) 24-gauge, Category 3 or better cable be used for all new installations.

- PS1

PS1 provides power over the ISDN signaling pairs (4&5, 3&6). In some instances, the NT1 will receive power over pins 7 and 8 and pass power to the ISDN terminal over PS1. To use this option, the user should make sure that the ISDN Terminal Equipment will operate from PS1, and that the NT1 power supply provides enough capacity for all ISDN equipment. The PS1 option is sometimes referred to as phantom powering. For cable wire assignments for PS1 power see Figure 5-8.

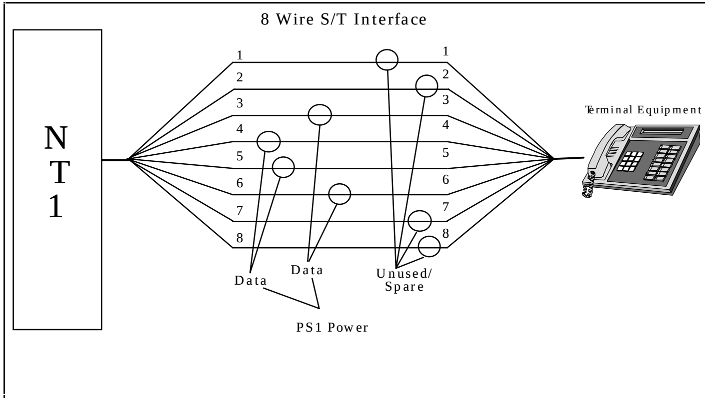

Figure 5-8 PS1 Power

- PS2

The PS2 option for powering ISDN is the most widely used of the powering options. PS2 is considered the primary power source to ISDN TE. Under this powering configuration, power is applied to a separate pair of wires (i.e., not on the ISDN signaling pairs). PS2 powering uses pins 7 and 8 of the S/T interface. The signaling pairs use pins 3,4,5 and 6. Pins 1 and 2 are not used. It is recommended that the unused wires be held as spares. For cable wire assignments for PS2 power see Figure 5-9.

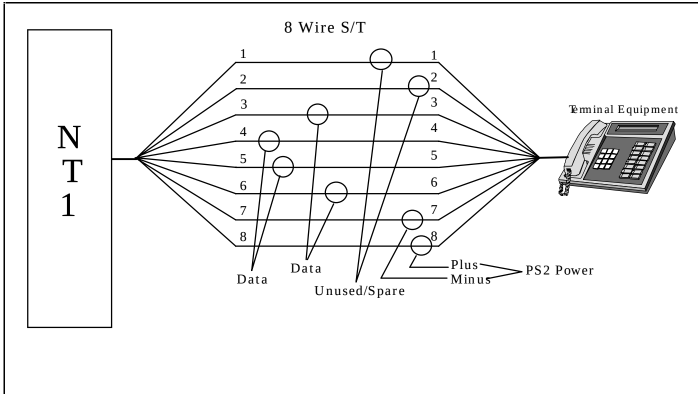

Figure 5-9 PS2 Power

- PS3

PS3 is provides power to ISDN Terminal Equipment through pins 1 and 2 of the S/T interface. The PS3 option is not presently used by the majority of ISDN Terminal Equipment manufacturers, however pins 1 and 2 should still be connected at both the TE and NT1, with the wires held as spares. For cable wire assignments for PS3 power see Figure 5-10.

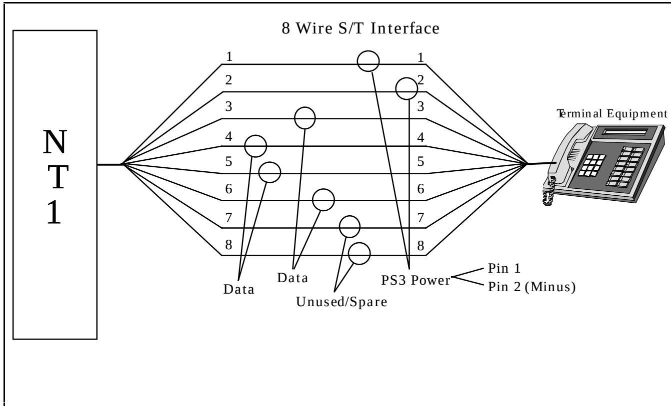

Figure 5-10 PS3 Power

5.4.1.2 Powering Options for the U Interface (NT1)

The standards specify that the power to the NT1 may be supplied on pins 7 and 8 of the U interface connector from an external power source. There may be additional powering options available. The NT1 power supply may pass power to the ISDN terminals using PS1 or PS2, as discussed in Section 5.4.1.1.

5.4.2 Powering Equipment Configurations

These guidelines describe three configurations for powering equipment: local, remote, and distributed.

Local power is defined as a power supply co-located with the equipment utilizing that supply. In this type of powering arrangement, the NT1 and TE(s) will be co-located in the same room or possibly integrated in the same unit. The power supply should be selected so that it can accommodate the powering needs of the NT1 and TE. Figure 5-11 depicts a local power arrangement.

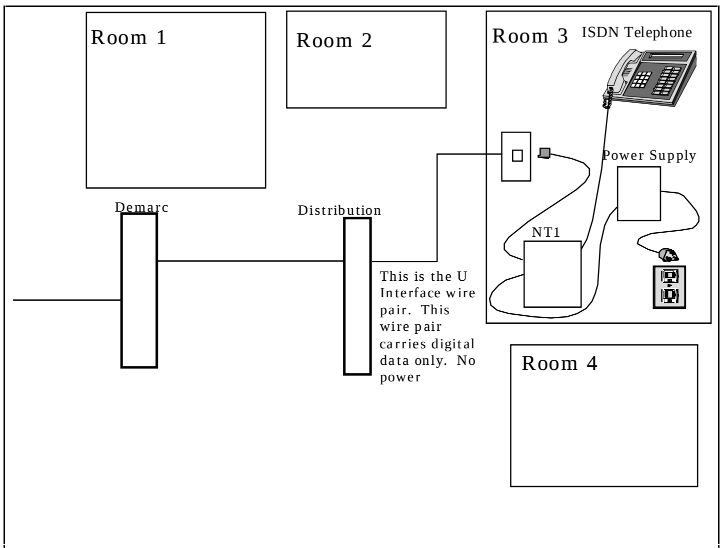

Figure 5-11 Local Power

Remote power (also called central or bulk power) is defined as a power supply that is found in some location other than where the equipment is located. Figure 5-12 depicts a remote power arrangement.

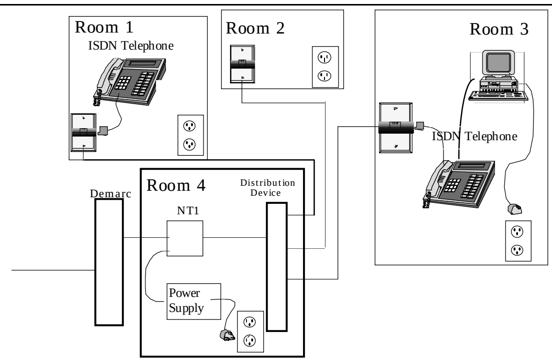

Figure 5-12 Remote Power

Distributed power is defined as multiple power supplies that may be arranged in any combination of local and remote power arrangements. Figure 5-13 depicts a distributed power arrangement where power is provided by one remote supply and two local supplies.

For all of these configurations, the wiring used to power ISDN equipment should be a star configuration. A distribution device may be used to distribute power to multiple locations.

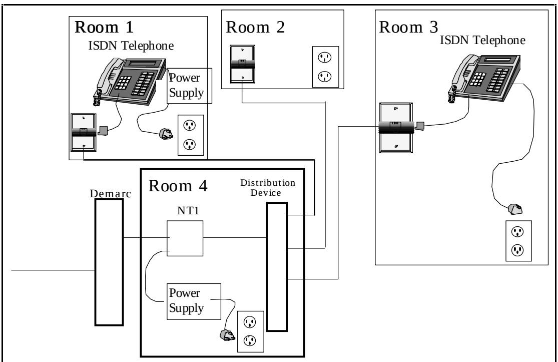

Figure 5-13 Distributed Power

5.4.3 Location of Power Sources

The location of the power source may depend on the type of building and the needs of the occupants. For example, each tenant may require a separate power source located at the tenant's premises. Section 6 provides additional details for power source locations for several building configurations. In general, the location for any power source should be easily accessible, and should have sufficient room for all of the equipment to be located there. The equipment should be mounted with enough room to remove all covers and access panels, allowing access to all screws and fastening hardware. In addition, the area should be cool, dry, and well ventilated. Consult the vendor's manual for recommended operating environment, and local codes for safety issues.

5.4.4 How to Select the Power Source

In order to determine the size of the power source needed, you must first analyze the layout of the building or tenant premises. Section 6 provides guidelines on planning the number of service outlets required and the location options for the power sources for these service outlets. The required size of the power source can then be found by adding together the powering requirements of all the equipment (ISDN phones, NT1s, etc.) to be powered by the power source. These powering requirements can be found by consulting the individual owner's manuals of the ISDN equipment. Make sure that the power requirements used to determine the size of the power source are the **<u>active</u>** power requirements for the equipment. Once you have determined the power required for the system, add an additional 10% for a total power requirement of 110% of the original power requirement. This final power requirement is the minimum size power source needed to support the equipment at full capacity traffic usage. If the expected traffic usage will be less than 100% full capacity, then it may be possible to reduce the size of the power supply. Consult the owner's manual for the equipment supported by the power source to determine whether the size of the power source can be reduced in this case.

5.4.4.1 Backup Power Source

Since ISDN terminal equipment relies entirely on the power source provided by the customer, it is vital to provide backup power for the ISDN equipment if the customer wishes to maintain ISDN service in the event of a normal power source failure. For most applications, backup power can be provided by a motor generator, batteries, or a combination of both.

5.4.4.1.1 Motor Generator Backup Systems

Motor generator backup systems are widely used in commercial applications to provide backup power for a variety of systems, including the telecommunications system of a building. Although guidelines for the size of motor generator backup systems is beyond the scope of this document, there is one important aspect that should be addressed. When normal (commercial) power fails, there may be a delay before the motor generator backup system takes over. Depending on the type of motor generator backup system used, this delay may vary from several milliseconds to many minutes. During this time delay, the telecommunications system may be interrupted. If it is important that the telecommunications system remain uninterrupted during this delay, battery power must be used to bridge this time. The amount of battery power required to bridge this time period depends on the amount of power to be supported and the length of the time delay. The motor generator equipment manufacturer's specification may contain information on the time delay. Once the time delay and power requirements are known, see Section 5.4.4.1.2 to determine the correct battery size for this application.

5.4.4.1.2 Battery Backup Systems

Battery backup systems may be used alone, or in conjunction with motor generator backup systems, as described in Section 5.4.4.1.1. The amount of battery backup required is specified by the customers needs. However, the backup time required should be considered the minimum time required for the desired length of operation. This section provides guidelines on the use of battery backup systems and on the size selection.

Batteries are not linear with regards to power output vs. time. In addition, the ambient temperature and usage may lead to variations in battery performance. The amount of reserve capacity available is also dependent upon time since the last power outage.

Although it may not be possible to provide an exact battery selection without consulting the data for the manufacturer of the batteries, we will attempt to provide information to approximate the size of the battery needed for the application.

A. Determining Power Needs

Once the total power load to be supported has been determined (using the procedures in Section 5.4.4), the total power for the load should then be divided by the Volts per load to determine the Amps needed for the battery. For example, if the total power load was 4.75 Watts, then the following equation would be used for 48 Volts per load:

Power for Load / Volts per load = Amps

4.75 W / 48 V = 0.0989 Amps

Amps would then need to be converted to a time reference. In the following equation, we use hours as the time reference:

Amps * Time of operation = Amp Hour discharge rate

0.0989 A * 5 hours = 0.4945 Amp Hour discharge rate

Since batteries are not linear with regard to power output vs. time, a battery with a 5 Amp Hour discharge rate may only have a 5 Amp output for the first 40 minutes of usage. After 5 hours, the output from the battery may have reduced to only 1 Amp.

B. Selecting the Battery

In the example above, we determined that the battery size should be able to supply 0.0989 Amps for 5 hours. Some battery ratings are given for a period of time such as 8 hours, 10 hours, 20 hours, etc. The larger the variation in time, the greater the variation will be in the current. To determine whether a battery, that has a rating based on a period of time other than that required for the system, will meet the needs of the system, it is necessary to perform some calculations to find what effect the current discharge rate may have on the battery's ability to supply the required current.

Take for example two batteries that are rated at the 20 hour rate. One has a capacity of 0.5 Amp Hours and the other has a capacity of 1 Amp Hours.

While 0.5 Amp Hours is greater than the 0.4945 Amp Hours that our system requires, the rate of current discharge affects the battery's ability to provide 0.0989 Amps for 5 hours. Thus, the 0.5 Amp Hour battery at the 20 hour rate would not be sufficient.

Even with the quicker discharge rate, the 1 Amp Hour battery at the 20 hour rate may be sufficient to provide our system with the necessary current at the required voltage for 5 hours. Most battery specifications provide information, i.e., in the form of a graph, that provides information on the effect of battery discharge. An example of a graph is one that shows various curves for various discharge rates with discharge voltage plotted against time. For our example, we would want to look at the curve that most closely corresponded to a 5 hour discharge time period. Each curve has a multiplier associated with it. The multiplier can then be used to determine whether the battery is appropriate for the required application. Using the example above, if the 1 Amp Hour battery had a graph that had a multiplier of 0.85 for 5 hours, the new Amp Hour rate would be determined by 0.85 * 1 = 0.85 Amp Hours. This is greater than the 0.4945 Amp Hours required for our system. Thus, the 1 Amp Hour battery would be a reasonable selection.

Thus, it is recommended that you check the battery specifications to determine the effect of rate of discharge on battery performance. Rate of discharge may have an effect on battery performance that varies from battery to battery. The faster the rate of discharge, the more significant the affect on performance. For example, if a battery with a 20 hour rating is used, but the backup time needed is only 30 minutes, the multiplier could be as low as 0.5.

Note that operating temperature will also have an affect on the calculations performed in this example. If the temperature at which the battery operates is less than the temperature at which the battery is rated, the battery will provide less than the rated capacity. Thus, the operating temperature will need to be considered when choosing battery size. The battery specifications should contain information on how the temperature will affect battery capacity.

Determining battery requirements for use with an Uninterruptable Power Supply (UPS) requires one additional step. The invertor section of the UPS may only be 70% efficient. Therefore, the total power load for the equipment to be supported by the backup system must be divided by 70% (or 0.70) to account for the 70% efficiency. This number should then be used as the total power for the load when calculating the battery rating as shown in the examples in this section.

6. ISDN Specific Guidelines for High Rise Buildings

This section contains information that is specific to high-rise buildings. While Sections 3, 4, and 5 have provided general information that is applicable to most building types, this section provides wiring configuration and planning information that is dependent on the building type and the occupancy of the building. Section 6.1 contains information on single occupant high rise buildings, such as a company's corporate headquarters. Section 6.2 contains information on multiple tenant high rise, such as apartment buildings.

6.1 Single Tenant High Rise Buildings

For the purposes of this document, a single tenant high rise is defined as a commercial building in which a single group is responsible for all premises wiring after the demarcation point. Figure 6-1 shows the general layout of the wiring for a high rise building.

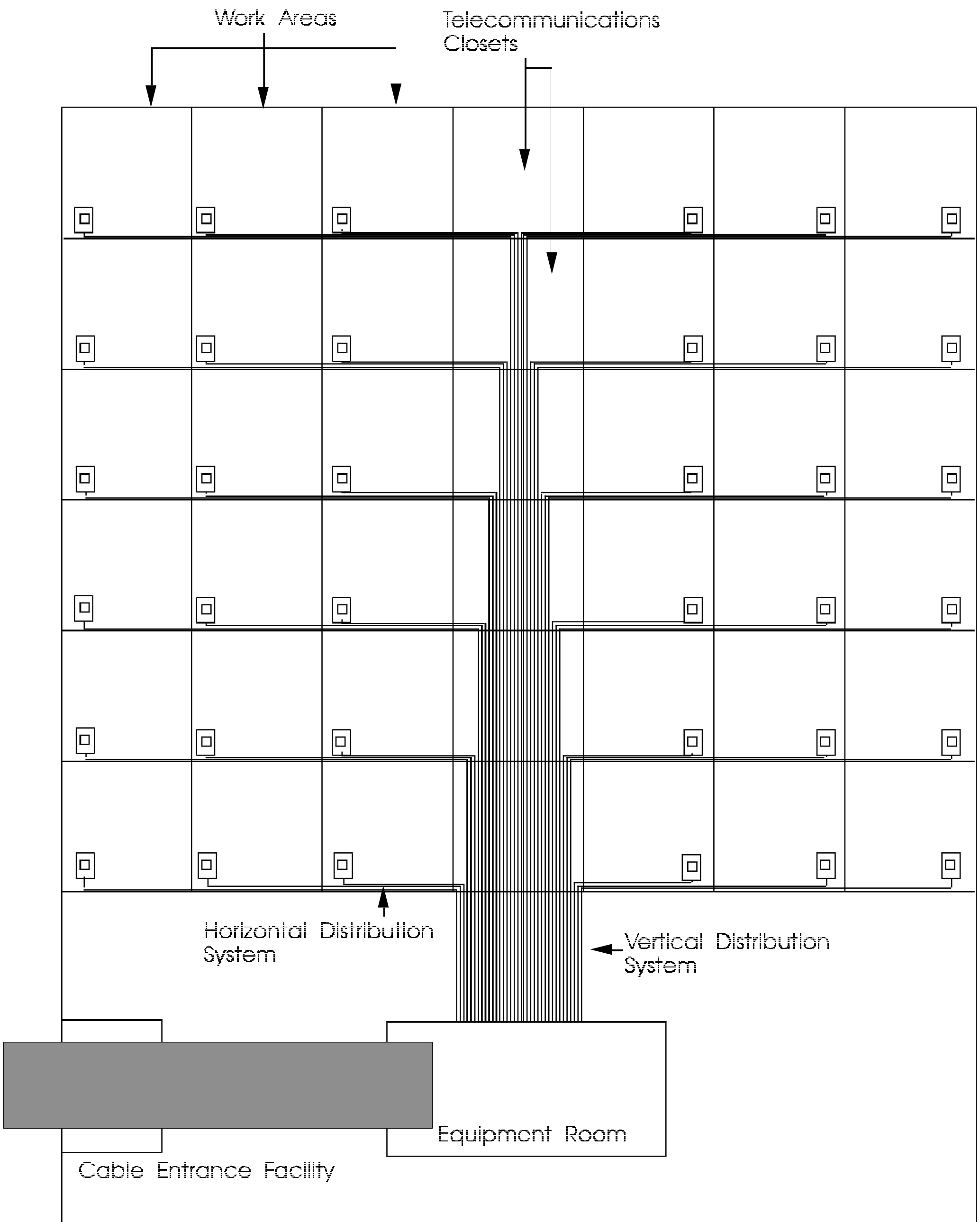

Figure 6-1: Example of Wiring Layout for Single Tenant High Rise

6.1.1 Planning

This section will detail planning issues for a single tenant high rise that along with Section 3 gives an outline for some of the issues that need to be considered when planning ISDN installation.

NOTE: When planning any wiring installation, be sure to account for all regulations for safety and fire, such as the Underwriter's Laboratory and the National Electrical Code. There may also be local codes that have additional requirements.

The following are the steps that are necessary for determining the wiring needs for the ISDN service.

1) Find the demarcation point.

Using the information given in Section 2, determine the location at which the responsibility of the service provider ends.

2) Determine the type and number of ISDN devices that will be used in the building.

This is dependent on the application needs of the people in the building. As mentioned in Section 3.2.1 a common set of terminals on the premise will reduce the number of different wiring configurations that will be necessary in the building. While this will determine some of the minimal wiring needs, step 3 will also drive additional wiring considerations.

3) Determine where the U interface and S/T interface will reside.

As mentioned earlier, the S/T interface must begin at or after the demarcation point. Another major factor that determines where the S/T interface begins is the number of NT1s and equipment for other telecommunication services that will be required. The telecommunications closet or equipment room will require enough space to house this equipment, its powering requirements, and still allow for expansion of services. Distance considerations as mentioned in Section 5 will also contribute to where the S/T interface can begin.

Although it may be possible to plan ahead and determine the number of U interface connections to service outlets that are needed in a building, it is recommended that lines have the capability of being used as either U interface or S/T interface.

In order to accomplish this, it will be necessary to use 8-position jacks as the service outlets for the work area. Lines that can be used as U interface and S/T interface must run directly from the equipment room to the service outlet. No other outlets should be connected to the line using distribution devices.

If the configuration requires an S/T interface at the work area, then the incoming ISDN lines must be wired to an NT1 in the equipment room or telecommunications closet before being routed to the 8-position jack.

If the configuration requires a U interface at the work area, the NT1 and power could be bypassed, using a jumper system. Therefore, the wires available at the 8-position jack will carry the U-interface to the work area. Transmit and receive will be carried over the center pins, allowing either a 6-position plug or an 8-position plug to be attached directly to the 8-position jack. Note that the disadvantage of this system is that four pairs are dedicated from the area where the NT1s reside to the 8-position jack and a U interface line to the work area only requires a single pair. If pairs are a scarce resource, this might not be the most efficient use of them. Note that this discussion assumes that power is not being carried over to the U-interface device. An extra pair is required for the case where the U-interface is remotely powered.

4) Determine the future ISDN needs of the building.

Planning for future services will be critical for an entire high rise building. This is primarily because of the number of wires that may be required and the fact that ISDN will need to share the wire infrastructure with other services.

It is not possible to foresee all the changes in telecommunications services that will ever be needed in a building. Although strong pre-planning will reduce problems in the future, it is not economical nor realistic to believe that all future needs will be accommodated in the initial planing period. Thus, it will be necessary to evolve the wiring with the needs of the building's occupants. These changes could be spurred by any number of changes. A few examples of these changes are the need for additional lines to work areas, replacement of older technologies, and re-configuration of work area layouts. These changes might require new additions to the equipment room and/or telecommunications closets. It could be necessary to accommodate equipment such as power supplies and racks of NT1s.

The limiting factor in these changes will be the amount of changes that need to be made to the horizontal cabling. Backbone cabling is relatively easier to replace. The wiring provided to each floor of the building can be expanded and/or changed in intervals of 5 to 10 years. This interval allows wiring changes to be made that will last for a significant amount of time, while still keeping the time span short enough for planning to be more accurate.

Because the limiting factor may be the horizontal wiring, it may be found that more horizontal wiring connections should be run to each work area to accommodate future expansions in service. A rule of thumb is to design for 30 to 50 percent spare capacity. Note that not every wire that is run to a work area needs to be connected to a service outlet. If the wire is determined to be needed for potential future services, it can be run to the work area location and left unconnected. When the new service is needed, the wire will only need to be attached to an existing or new service outlet reducing the cost of running the entire length of cable. Be sure to follow proper wiring codes, if leaving wire unconnected to a service outlet.

NOTE: Horizontal distribution cable is more difficult to access and replace than backbone cabling. It is, therefore, better to slightly overestimate the number of cables that will be needed from the telecommunications closet to each work area.

5) If the building is not new, ascertain the current wiring layout and limitations of the building.

Refer to Section 3.1.1 for further information.

6) Determine whether new or existing wiring should be used.

Based on the results of step 5, determine if existing wiring can be used. If there is any doubt, it is recommended that new wiring is run for ISDN services.

7) Factor in other services when wiring for ISDN.

Because the cost of additional cabling is small in comparison to the cost of rewiring at a later date, it may be the best solution to run several types of horizontal wiring - fiber, UTP, and STP - to each work area, even if they are not planned to be used in the short term.

As mentioned in Section 3, shared sheath analysis might be necessary to determine crosstalk effects if ISDN and other services coexist in the same cable.

6.1.2 Wiring

Good wiring practice should be exercised in order to provide for ease of installing and maintaining the wiring. An overview of some of considerations can be found in Appendix A.

The final wiring configuration will be determined by where the NT1s and power are located. Refer to the appropriate sections in Section 5 for the wiring configuration that meets the needs of the applications that are intended to use ISDN service.

6.1.3 Powering

For the single tenant high rise building, power for the telecommunications equipment can be supplied through local power sources, remote power sources or distributed power sources. The choice may depend on a number of factors including:

- the number of ISDN service outlets to be supported,
- whether there is sufficient room for several power sources in a remote location (e.g., equipment room or telecommunications closet),
- can the existing power grid within the building support power for the ISDN service,
- if existing wiring is to be used, can it support power transmission from the remote location to each service outlet,
- placement of the NT1s; for example, if the NT1s are rack mounted in an equipment room, then it may be desirable to have a power source near or in the equipment room.

Section 5.4 contains additional guidelines on choosing the size of the power sources, and guidelines for backup power systems.

6.2 Multi Tenant High Rise Buildings

For the purposes of this document, a multi tenant high rise is defined as a commercial or residential building in which a group is responsible for the wiring in some subsection of the building. For instance, the demarcation point may be in the equipment room, the landlord of the building may be responsible for the wiring in the riser, and the tenant may be responsible for the wiring from the telecommunications closet to their premises and the wiring inside the premises. See Figure 6-2.

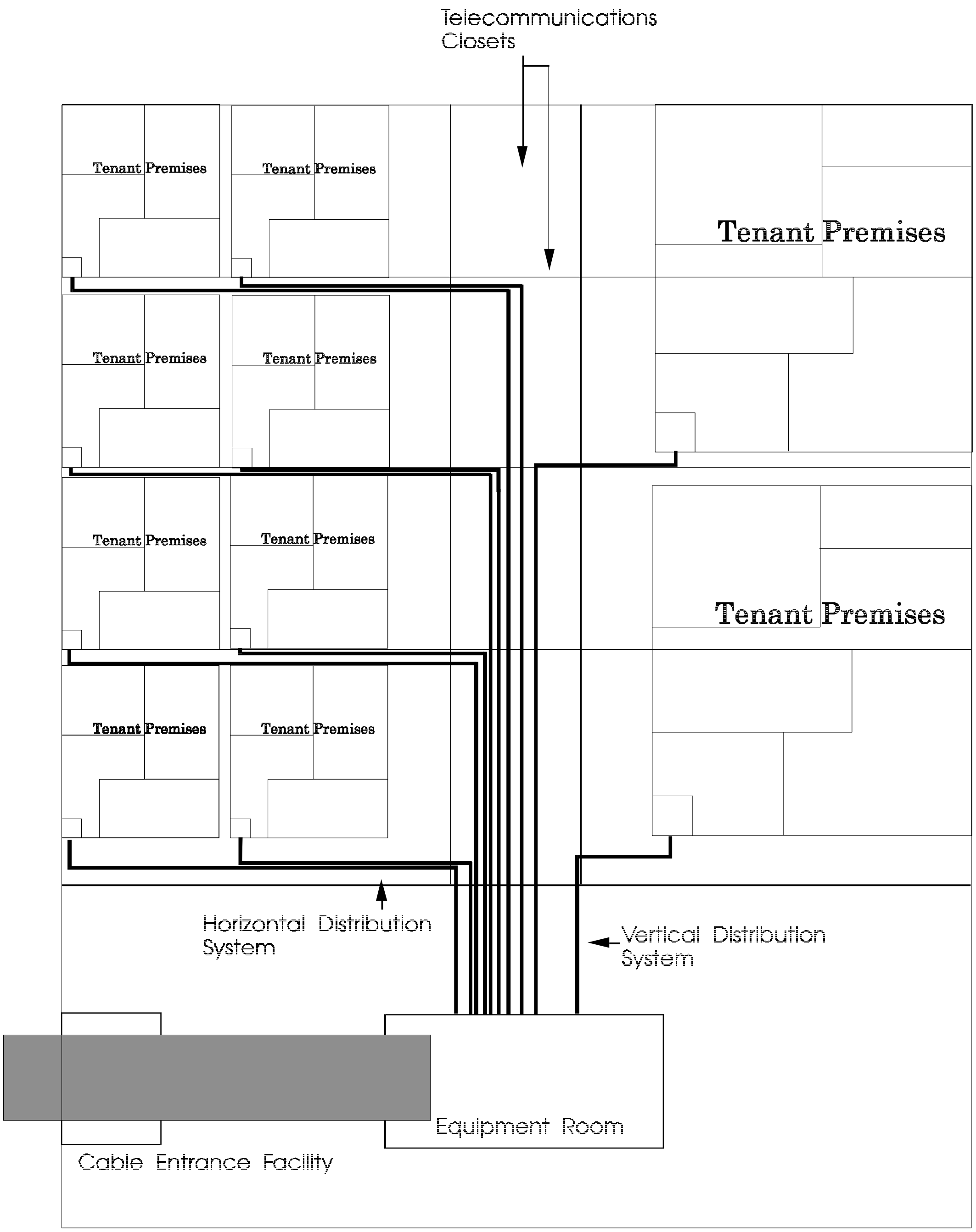

Figure 6-2: Example of Wiring Layout for Multi-Tenant High Rise

6.2.1 Planning

This section will detail planning issues for a multi-tenant high rise that along with Section 3 gives an outline for some of the issues that need to be considered when planning ISDN installation.

NOTE: When planning any wiring installation, be sure to account for all regulations for safety and fire, such as the Underwriter's Laboratory and the National Electrical Code. There may also be local codes that have additional requirements.

For the purpose of this section, two terms are defined here. The **tenant premise** is defined as the particular area in which the tenant who is installing ISDN resides or occupies. Examples of tenant premises are apartments and a suite of office space. The **tenant entrance point** is defined as the point where the tenant's wiring responsibility begins. Note that this point will not necessarily coincide with the demarcation point. Further, this may not be the point where the wiring first enters the tenant premise. Thus, the tenant entrance point may not necessarily reside on the tenant premise and the tenant may be responsible for some wiring outside of the tenant premise.

The following are the steps that are necessary for determining the wiring needs for the ISDN service.

1) Find the demarcation point.

Using the information given in Section 2, determine the location at which the responsibility of the service provider ends.

2) Find the tenant entrance point, if it is different from the demarcation point.

The tenant entrance point will depend on the policy of the building landlord or owner. Not only will the demarcation point vary from structure to structure, but the tenant entrance point can vary from the demarcation point depending on where the inside wiring responsibility resides.

3) Determine the type and number of ISDN devices that will be used on the tenant's premise.

This is dependent on the application needs of the people in the tenant premise. As mentioned in Section 3.2.1, a common set of terminals on the premise will reduce the number of different wiring configurations that will be necessary on the tenant premise. While this will determine some of the minimal wiring needs, step 4 will also drive additional wiring considerations.

4) Determine where the U interface and S/T interface will reside.

The first location where the S/T interface can begin is at the demarcation point. It is recommended that if the tenant entrance point is not the same as the demarcation point, that the S/T interface start no earlier than the tenant entrance point. Further, it may be important to have the S/T interface begin on the tenant premise. Because the area between the tenant entrance point and the demarcation point is not within the responsibility of the tenant, the tenant has no control over the wiring and, therefore, may not want to run the S/T interface over that wire. Also, if the NT1s reside off the tenant premise, there must be guarantees that the tenant can gain access to the area if the NT1s need to be re-configured or troubleshooting becomes necessary.

5) Determine the future ISDN needs of the tenant's premise.

The bottom line is to plan ahead. Even if only a few ISDN lines are being installed currently, determine whether current POTS lines will be able to be transitioned easily to ISDN, if that change needs to be made in the future.

6) If the tenant entrance point is not the same as the demarcation point, determine what sort of wiring exists between the demarcation point and the tenant entrance point and who is responsible for this wiring.

There are several considerations for the wiring between the demarcation point and the tenant entrance point. It must be adequate for carrying ISDN services and, thus, must meet the minimum cable requirements described in Section 4. It must contain the required number of wires from the demarcation point to the tenant entrance point. It is important to know who is responsible for this wiring. This will be necessary to address issues such as repair and maintenance as well as what needs to be done in the case where new wire needs to be run from the demarcation point to the tenant premise point to accommodate ISDN service.

7) Ascertain the current wiring layout and limitations inside the tenant premise.

Refer to Section 3.1.1 for further information.

8) Determine whether new or existing wiring in the tenant premise can be used.

Based on the results of step 7, determine if existing wiring can be used. If there is any doubt, it is recommended that new wiring is run for ISDN services.

6.2.2 Wiring

If the demarcation point is the same as the tenant entrance point and is on the tenant premise, the wiring for the tenant premise becomes analogous to the wiring for residences or small businesses. For this case the user is referred to NIUF/ICSW/BRI/060, “ISDN Wiring and Powering Guidelines for Residence and Small Business (Version 2),” for the necessary wiring configuration. See Figure 6-3.

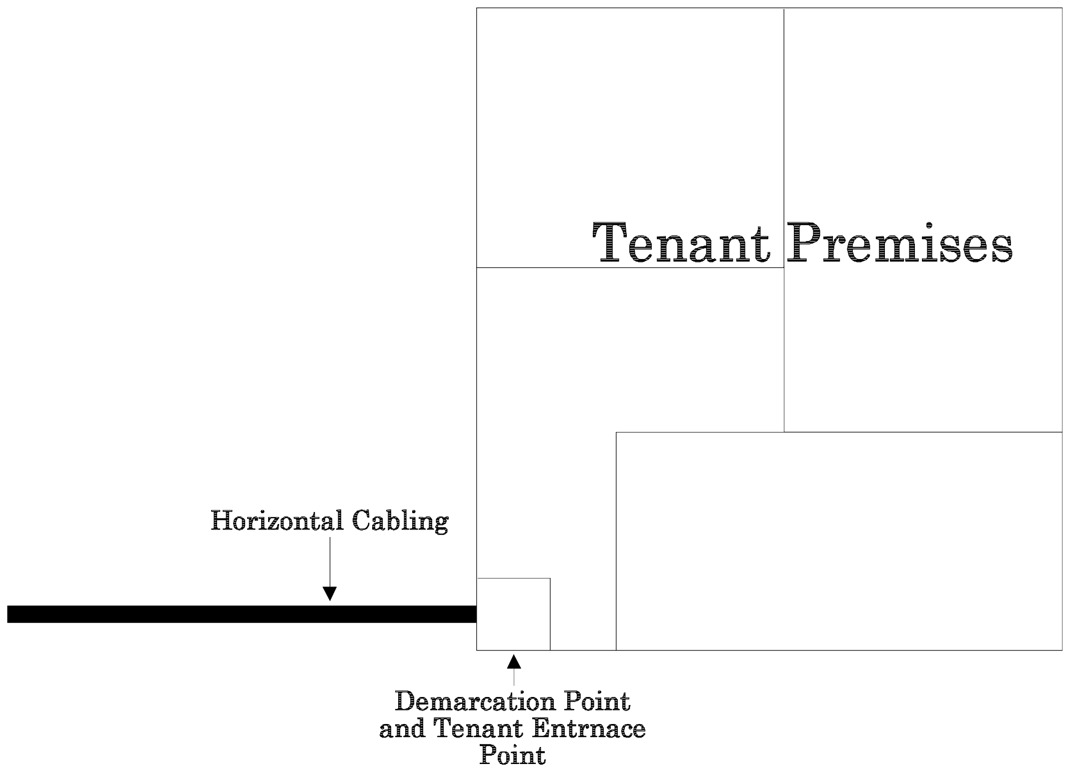

Figure 6-3 - Demarcation Point on Tenant Premise

If the demarcation point is not the same as the tenant entrance point and tenant entrance point is on the customer premises, then the tenant will need to guarantee that the wiring between the points meets the necessary requirements for running ISDN. The tenant premise may then be wired to the ISDN Wiring and Powering Guidelines (Residences and Small Businesses). This is assuming that the tenant entrance point is on the tenant premise. See Figure 6-4. If the tenant premise spans several floors, then the premise may be treated as a single tenant building as described in Section 6.1.

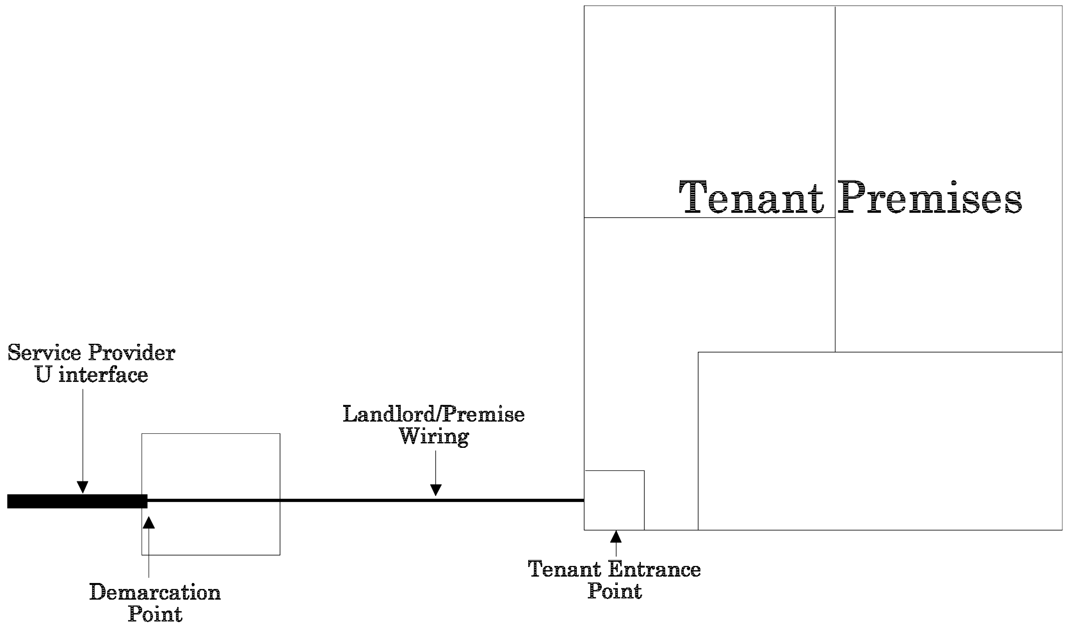

Figure 6-4 - Demarcation Point off Tenant Premise,
Tenant Entrance Point on Tenant Premise

If the demarcation point and the tenant entrance point are at the same point that is not on the tenant premise, the tenant will be responsible for the wiring from the demarcation point to the actual ISDN equipment. The tenant has the option of running the U interface to the tenant premise. In this case, the wiring on the customer premise will follow the ISDN Wiring and Powering Guidelines (Residences and Small Businesses). If the tenant premise spans several floors, then the premise may be treated as a single tenant building as described in Section 6.1. The wiring from the demarcation point to the tenant premises must meet the minimum wiring specifications given in this document. At least one pair per line will be required to be run from the demarcation point to the tenant premises. Another option the tenant has would be to locate the NT1s between the demarcation point and the tenant premises and run the S/T interface to the tenant premise. In this case the wiring should follow Sections 5.2.1 or 5.2.2. See Figure 6-5.

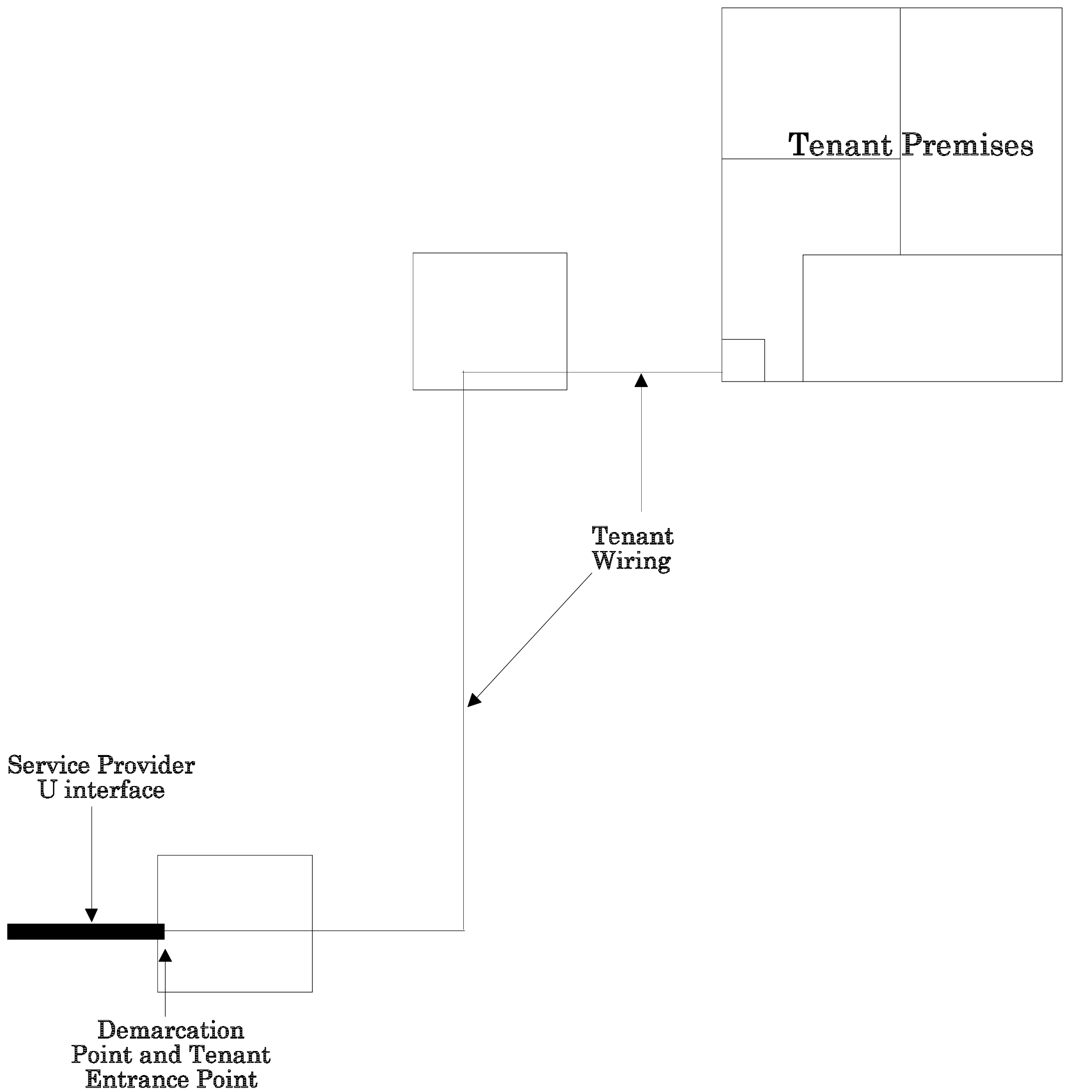

Figure 6-5 - Demarcation Point/Tenant Entrance Point off Tenant Premise

If the demarcation point and the tenant entrance point are at different locations that are both not on the tenant premise, the tenant will be responsible for the wiring from the tenant entrance point to the actual ISDN equipment. The tenant will need to determine who is responsible for the wiring from the demarcation point to the tenant entrance point. This wiring is referred to as landlord/premise wiring. The tenant has the option of running the U interface to the tenant premise from the tenant entrance point. In this case, the wiring on the customer premise will follow the ISDN Wiring and Powering Guidelines (Residences and Small Businesses). If the tenant premise spans several floors, then the premise may be treated as a single tenant building as described in Section 6.1. The wiring from the tenant entrance point to the tenant premises must meet the minimum wiring specifications given in this document. At least one pair per line will be required to be run from the demarcation point to the tenant premises. The tenant will also need to determine if there are enough pairs in the landlord/premise wiring and whether the landlord/premise wiring meets the minimum specifications needed for ISDN service. Another option the tenant has would be to locate the NT1s between the tenant entrance point and the tenant premise and run the S/T interface to the tenant premise. In this case the wiring should follow Sections 5.2.1 or 5.2.2. Because the NT1s are not on the tenant premise, the tenant must be able to ensure that they can access the location of the NT1s. A third option would be to locate the NT1s at the demarcation point or somewhere before the tenant entrance point. This might become difficult, because the S/T interface and NT1s would need to reside and make use of wiring outside of the responsibility and control of the tenant. See Figure 6-6.

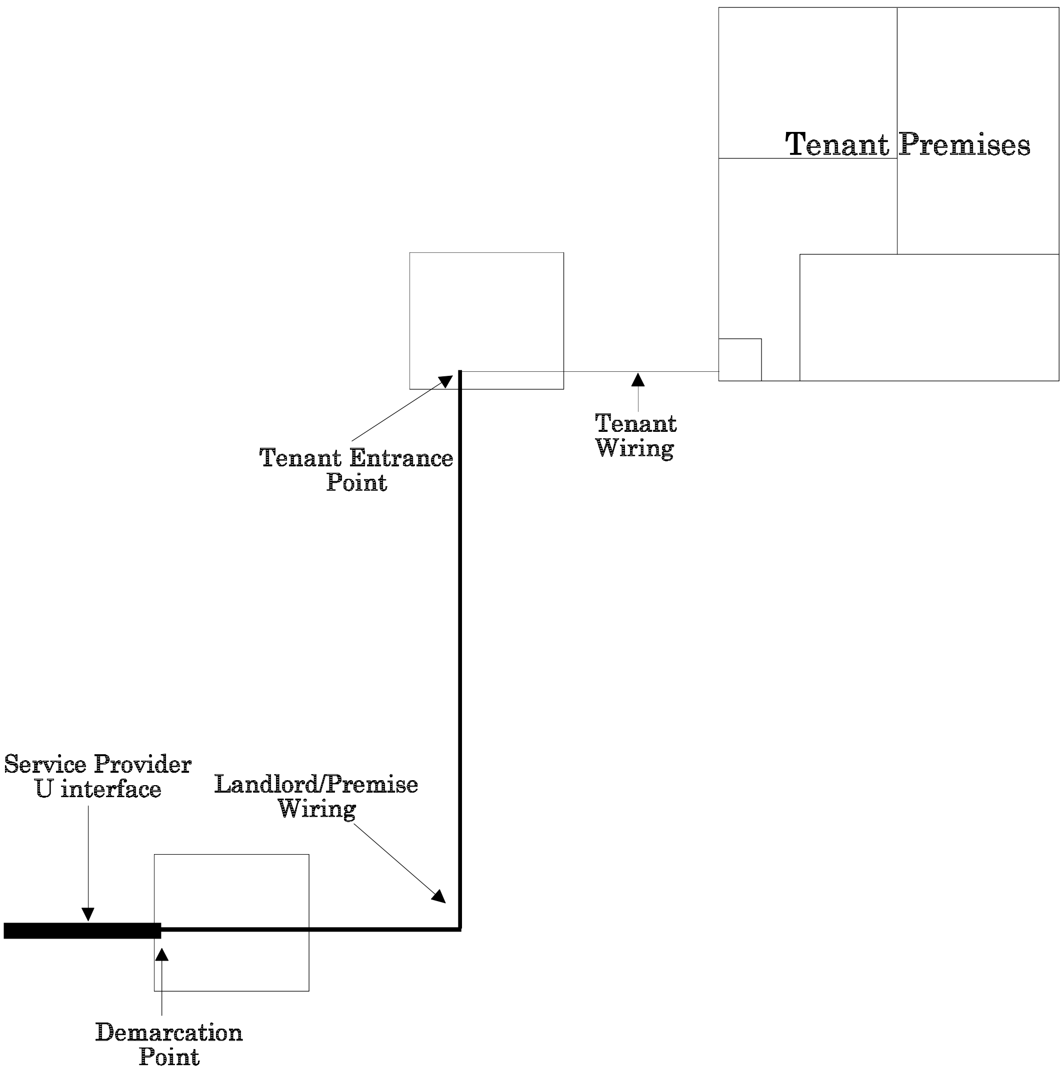

Figure 6-6 - Separate Demarcation Point and Tenant Entrance Point off Tenant Premise

6.2.3 Powering

For a multi tenant building, each tenant will most likely require a separate power system for their ISDN service. The type of power system required will depend on the size of the tenant premises and the number of ISDN service outlets to be supported.

Section 5.4 provides background information on local, remote and distributed power sources, and on determining the size of the power source needed.

If the tenant premises is a small office or residential suite, then this case may closely resemble that of a single home. NIUF/ICSW/BRI-022 provides guidelines for ISDN powering for residential buildings. If the tenant premises is quite large (spanning several floors) then the premises may be treated as a single tenant building. Section 6.1.3 provides alternatives for this case.

If a backup power system is desired, then see section 5.4 for guidelines on types and sizes of backup systems.

7. ISDN Specific Guidelines for Campuses

This section contains information that is specific to campuses. While Sections 3, 4, and 5 have provided general information that is applicable to most building types, this section provides wiring configuration and planning information that is dependent on the building type and the occupancy of the building. Section 7.1 contains information on campus layouts. For campuses that provide emergency services or other specialty applications, the reader is also referred to Section 9.

7.1 Campuses

There are several different types of campuses - single-tenant commercial, mixed commercial/residential, and multiple-tenant commercial. For the purposes of this document, a campus is defined as a collection of residential and/or commercial buildings located in a common area in which a single group is responsible for all premises wiring after the demarcation point(s). Figure 7-1 and Figure 7-2 show the general layout of the wiring for a campus.

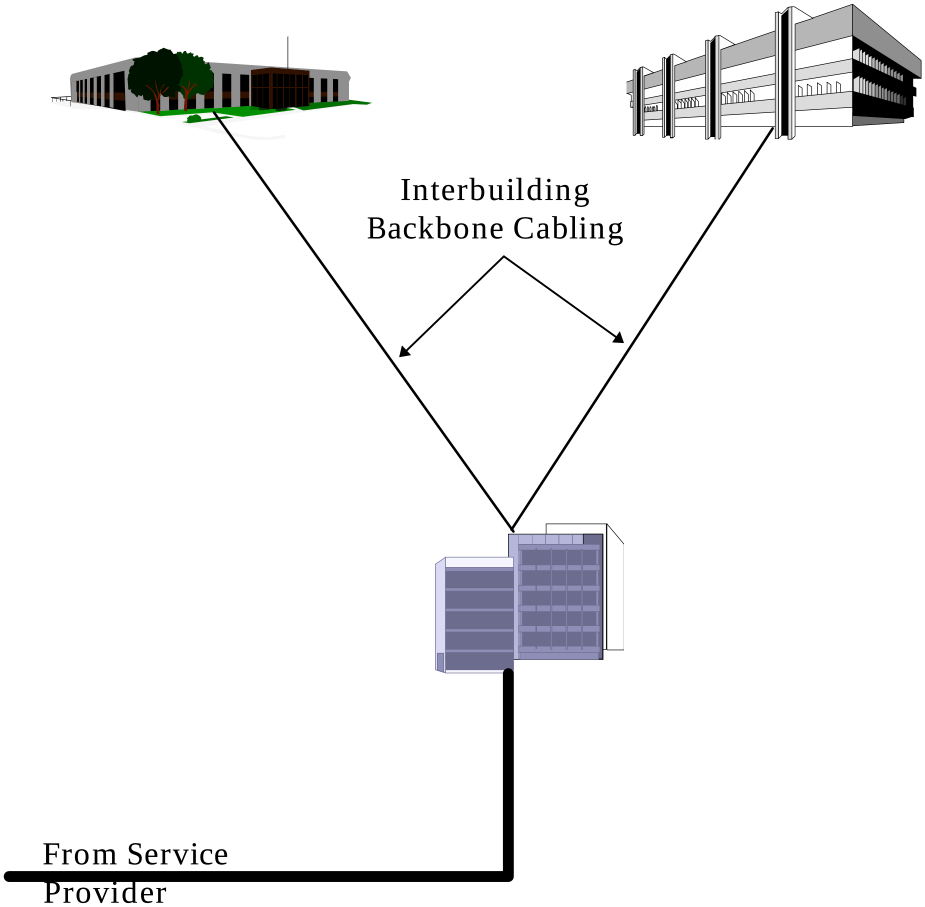

Figure 7-1: Campus Layout

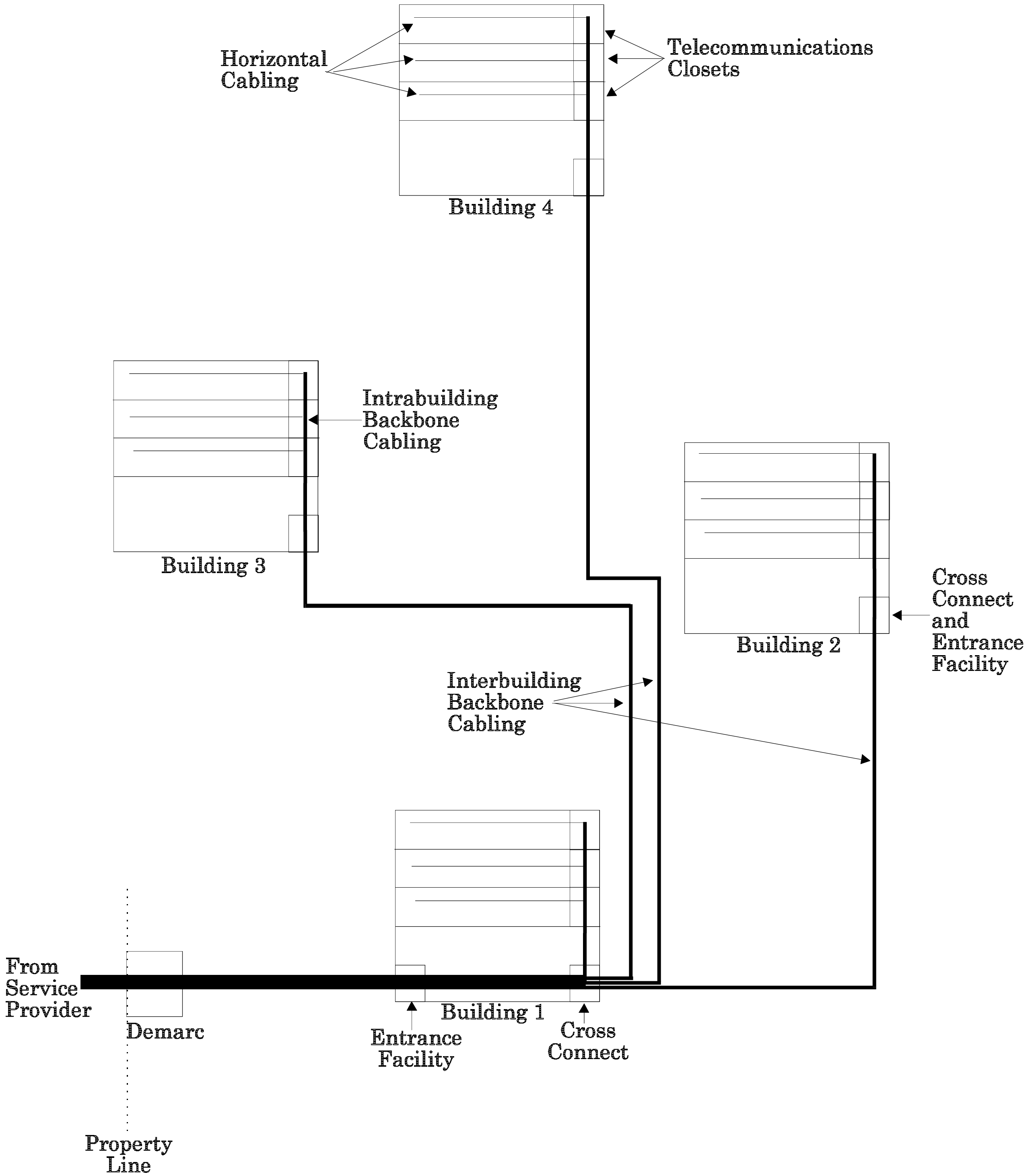

Figure 7-2: Example of Wiring Layout for a Campus

7.1.1 Planning

This section will detail planning issues for a campus that along with Section 3 gives an outline for some of the issues that need to be considered when planning ISDN installation.

NOTE: When planning any wiring installation, be sure to account for all regulations for safety and fire, such as the Underwriter's Laboratory and the National Electrical Code. There may also be local codes that have additional requirements.

The following are the steps that are necessary for determining the wiring needs for the ISDN service.

1) Find the demarcation point(s).

Using the information given in Section 2, determine the location(s) at which the responsibility of the service provider ends. For a campus, there may be a single demarcation point at a single building on the campus or at a location (e.g., underground entrance facility) at the property line if there is no building on the property line. In this case, the wiring around the campus is under the responsibility of the campus. For some installations, there also may be a number of demarcation points at several different buildings.

2) Determine requirements.

Based on the outcome of the first step, determine whether each building may be treated independently. If there are separate demarcation points for each building, each building can be wired using the guidelines given earlier in this document for Commercial and Multi-tenant Residential buildings. If there is a single demarcation, each building needs to be studied individually to determine its needs. After each building is accessed, the requirements of each building will determine the necessary cabling that needs to feed the campus. Additional planning may be required to run wiring from a demarc at the property line to all of the different buildings. This planning will depend on whether the service provider demarc arrives via an underground entrance, a buried entrance, or an aerial entrance.

2) Determine the type and number of ISDN devices that will be used on campus.

This is dependent on the application needs of the people on campus. As mentioned in Section 3.2.1, a common set of terminals on the premises will reduce the number of different wiring configurations that will be necessary in each building. While this will determine some of the minimal wiring needs, step 3 will also drive additional wiring considerations.

3) Determine where the U interface and S/T interface will reside.

As mentioned earlier, the S/T interface must begin at or after the demarcation point. Another major factor that determines where the S/T interface begins is the number of NT1s and equipment for other telecommunication services that will be required. The telecommunications closet or equipment room will require enough space to house this equipment, its powering requirements, and still allow for expansion of services. Distance considerations as mentioned in Section 5 will also contribute to where the S/T interface can begin.

It is not recommended to run the S/T interface between buildings. Considerations such as distance and susceptibility of the S/T interface to crosstalk and other interference make the wiring of the S/T interface outdoors undesirable. If it is necessary to run the S/T interface between buildings, be sure to use cabling that can withstand the environmental conditions. It will also be important to be aware of what other services may share the sheath with the ISDN pairs. A shared sheath analysis is recommended.

4) Determine the future ISDN needs of the campus.

Planning for future services will be critical for an entire campus. This is primarily because of the number of wires that may be required and the fact that ISDN will need to share the wire infrastructure with other services.

It is not possible to foresee all the changes in telecommunications services that will ever be needed in a building. Although strong pre-planning will reduce problems in the future, it is not economical nor realistic to believe that all future needs will be accommodated in the initial planing period. Thus, it will be necessary to evolve the wiring with the needs of the campus' occupants. These changes could be spurred by any number of changes. A few examples of these changes are the need for additional lines to work areas, replacement of older technologies, re-configuration of work area layouts, and addition of new buildings. These changes might require new additions to the equipment room and/or telecommunications closets. It could be necessary to accommodate equipment such as power supplies and racks of NT1s.

It will also be necessary to consider future occupation plans of the campus. If some of the buildings in the future may be subleased to other parties, certain wiring configurations may limit the access of those parties to wiring that feeds their building.

In a specific building, the limiting factor in these changes will be the amount of changes that need to be made to the horizontal cabling. Backbone cabling is relatively easier to replace. The wiring provided to each floor of the building can be expanded and/or changed in intervals of 5 to 10 years. This interval allows wiring changes to be made that will last for a significant amount of time, while still keeping the time span short enough for planning to be more accurate.

Because the limiting factor may be the horizontal wiring, it may be found that more horizontal wiring connections should be run to each work area to accommodate future expansions in service. A rule of thumb is to design for 30 to 50 percent spare capacity. Note that not every wire that is run to a work area needs to be connected to a service outlet. If the wire is determined to be needed for potential future services, it can be run to the work area location and left unconnected. When the new service is needed, the wire will only need to be attached to an existing or new service outlet reducing the cost of running the entire length of cable. Be sure to follow proper wiring codes, if leaving wire unconnected to a service outlet.

NOTE : Horizontal distribution cable is more difficult to access and replace than backbone cabling. It is, therefore, better to slightly overestimate the number of cables that will be needed from the telecommunications closet to each work area.

5) If the building is not new, ascertain the current wiring layout and limitations of the building.

Refer to Section 3.1.1 for further information.

6) Determine whether new or existing wiring should be used.

Based on the results of step 5, determine if existing wiring can be used. If there is any doubt, it is recommended that new wiring is run for ISDN services.

7) Factor in other services when wiring for ISDN.

Because the cost of additional cabling is small in comparison to the cost of rewiring at a later date, it may be the best solution to run several types of horizontal wiring - fiber, UTP, and STP - to each work area, even if they are not planned to be used in the short term.

As mentioned in Section 3, shared sheath analysis might be necessary to determine crosstalk effects if ISDN and other services coexist in the same cable.

7.1.2 Wiring

Good wiring practice should be exercised in order to provide for ease of installing and maintaining the wiring. An overview of some of considerations can be found in Appendix A.

If U-interface wiring is to be run between buildings, backbone cabling should be used. It will need to be properly protected from environmental conditions (e.g., use of conduit). Refer to local building codes and wiring practices for information on the installation of outside wiring. If the conduit from the demarc to the entrances of campus buildings is not owned by the service provider, it is recommended that entrance conduit for ISDN and POTS services not occupy the same conduit as other services (e.g., CATV).

If the campus is large, it will be necessary to determine that the distance that the U-interface is extended beyond the demarcation point does not cause the recommended loop lengths of the U-interface to be exceeded. Although the actual loop length of the U-interface varies dependent on the type of cabling and other factors, 18 kft can be used as a rule of thumb. Thus, the distance between the central office that houses the ISDN switch that provides the ISDN service and the location at which the NT1s are going to reside should not exceed 18 kft if U-interface loop extender cards are not employed in the service provider's network. If difficulties arise with the U-interface, determine from your service provider the distance between the central office or intermediate loop extension device and the demarcation point. Then determine whether the interbuilding U-interface distances will cause the recommended U-interface loop length to be exceeded.

NOTE: The 18 kft number is only a rule of thumb that is based on existing loop plant. The actual length may vary above or below 18 kft and needs to be determined on a case by case basis.

If it is necessary to extend the U-interface beyond the loop length limit after the demarcation point, it is necessary to use a loop extender. A loop extender is a device that is capable of extending the U-interface length by regenerating the U-interface signal. If such a device is employed, it is recommended that considerations be given to the wiring, powering, testing capabilties, and housing requirements of the loop extender. Consult your service provider and the literature of the manufacturer of the loop extender for specific details on how the device should be connected.

When wiring between buildings, backbone distance considerations must still be taken into account. The point at which the wiring enters the new building can be treated as a main cross-connect or an intermediate cross-connect.

At the entrance and exit to each building, Lightning Protection requirements must be taken into account. Refer to ANSI T1.601 Appendix B for information and references regarding Lightning Protection at the U-interface. Any back-up cabling entrances should contain the same protection as the main entrance points. Additional information on grounding and electrical protection for campus buildings may also be found in the BICSI Telecommunications Distribution Methods Manual.

Once inside a particular building, the final wiring configuration will be determined by where the NT1s and power are located. Refer to the appropriate sections in Section 5 for the wiring configuration that meets the needs of the applications that are intended to use ISDN service.

7.1.3 Powering

Section 5.4 contains guidelines on choosing the size of the power sources, and guidelines for backup power systems. This section contains additional information specific to campus environments.

A campus environment by its very nature, poses some interesting problems for the powering of ISDN equipment. In the campus environment it is necessary to contend with equipment spread out in several building locations.

7.1.3.1 Alternative Installation Types

As mentioned earlier, there are several possible alternatives for how ISDN lines are fed to the campus. These alternatives will affect the powering guidelines.

One alternative is a centrally located equipment room. All incoming facilities feed into this room and spread out over the campus from this location. Cross connecting to other buildings is done in this room. Changes to existing service may also be done here.

A second alternative is separate incoming facilities are run to each building individually. Each set of lines terminates in a closet in one of the buildings. From each closet, service is spread throughout the building.

A third alternative is that incoming facilities are run into a single building. Inside of this building is a dedicated central office switch or PBX. The incoming facilities are fed into the switch and the lines are fed out to the stations, spread out across the campus.

In the fourth alternative, the campus is served by digital loop carrier. The incoming facilities are usually terminated into an outdoor cabinet to a remote carrier and distributed across the campus.

Since ISDN may be installed into both new and existing buildings, the type of installation will require careful study and planning to cover present and future powering requirements.

7.1.3.2 Powering Guidelines

As with all ISDN installations powering is required at the customer premise. Powering has certain requirements common to all installations. One of the limitations is distance with regards to equipment power draw. Backup powering requirements impose another limitation. Certain rules apply regardless of installation type. These rules can not be violated or the system will not work. They need to be kept in mind by the systems engineer when planning the installation.

A. Considerations for Centrally Located Power

In a campus centrally located power is something to consider carefully. This will most likely be considered when there is a central switch or PBX system being used across the campus, but may not be appropriate for digital loop carrier. Power is already required for this equipment. Increasing the power plant slightly could help power all the stations through power distribution from the central location. There will need to be enough physical space to accommodate this equipment.

Consider first the distance between buildings. How far does the power have to be distributed? This alone can cause some problems. An example is a case where the power is distributed between neighboring buildings that are 100 feet apart. Consideration must be given for voltage drop along the wire. Assume that the terminal that is receiving power can operate at a distance of 700 feet from the power source. 600 feet of wire is available to run the power through the building. It is necessary to determine if this distance is sufficient for the installation needs. If, on the other hand, the next building is 1320 feet away, the terminal in the above example that resided in that building would not be able to be powered from the central location.

Wire size plays a large part in how far you can distribute DC power before it dissipates beyond the required specifications. The voltage drop along the cable between buildings needs to be taken into account. This will reduce the distance that terminals can be located from the distribution panel. Power may be distributed using the same wire gauge as ISDN service. This wire is 24 gauge and is associated with a characteristic voltage drop along the wire. A wire size of 18 gauge can increase the distance that the power can be distributed, since the 18 gauge has less resistance than 24 gauge. However, 18 gauge is not standard loop wire for telecom applications. It is possible to run large wire between buildings. Moving the power distribution panel away from the central plant will require investigating the amount of current required to pass on this wire so that the wire is properly sized. The amount of power lost in the run from building to building is directly dependent upon the size of the cable used to carry the power.

The second consideration is how the wire will get from point A (the central location) to point B (the station). There are several methods of running wire. The first is aerial (i.e., to string the wire from pole to pole). The second is to bury the wire in the ground. The third is to run the wire through existing underground service ways. In each case the wire must be chosen for the environment in which it will be used. Several environmental factors need to be taken into account like moisture, soil content, wind, and temperature. The wire must exist in the environment without degradation to the insulation which could result in failure.

The third consideration is the reserve time needed during a power failure. What type of equipment will provide backup power to the commercial power? Also, how long is backup power required? Where is the backup equipment located? Are there any limitations being placed upon the operation of the telecom system by the backup system? The backup power distribution will need the same considerations as the primary source for distance and how it will be distributed.

The fourth consideration is financial. What is the cost for providing this powering method? While initially it may appear to be the most effective way of doing things, the cost of burying the cable and the cost of running the cable could end up making this solution too costly.

B. Considerations for Local Powering

Locally powering ISDN stations is the easiest method for use in the campus environment. However, this method is also the most expensive. If the NT1 and the terminal reside at the same location, it is possible to provide powering for this equipment locally. If powering is done locally at the NT1 and the terminal, distance between buildings and environmental factors for outdoor wiring need not be taken into consideration. Backup power requirements still have to be addressed with this solution.

C. Considerations for Building Power

It is possible to look at each building as a separate entity. This solution provides a form of distributive power/central power. Power loss due to distance considerations are not as important since the power is distributed in a single building. Power can be considered as central power because one power plant can feed the entire building.

This would seem to be the easiest possible solution to implement. Outside cabling considerations are not existent. Distance between building considerations are not important for powering. This solution is similar to planning for an installation for a multi tenant building.

For a campus environment, power for the telecommunications equipment can be supplied through local power sources, remote power sources or distributed power sources. The choice may depend on a number of factors including:

- the number of ISDN service outlets to be supported,

- whether there is sufficient room for several power sources in a remote location (e.g., equipment room or telecommunications closet),

- can the existing power grid on campus support power for the ISDN service,

- if existing wiring is to be used, can it support power transmission from the remote location to each service outlet,

- placement of the NT1s; for example, if the NT1s are rack mounted in an equipment room, then it may be desirable to have a power source near or in the equipment room.

8. ISDN Specific Guidelines for Strip Malls

This section contains information that is specific to strip malls. While Sections 3, 4, and 5 have provided general information that is applicable to most building types, this section provides wiring configuration and planning information that is dependent on the building type and the occupancy of the building. Section 8.1 contains information on strip malls.

8.1 Strip Malls

For the purposes of this document, a strip mall is defined as a single building that is occupied by multiple tenants. As opposed to a multi-tenant high rise, a strip mall layout does not have many vertical levels, but instead covers a large horizontal area. Figure 8-1 shows the general layout of the wiring for a strip mall.

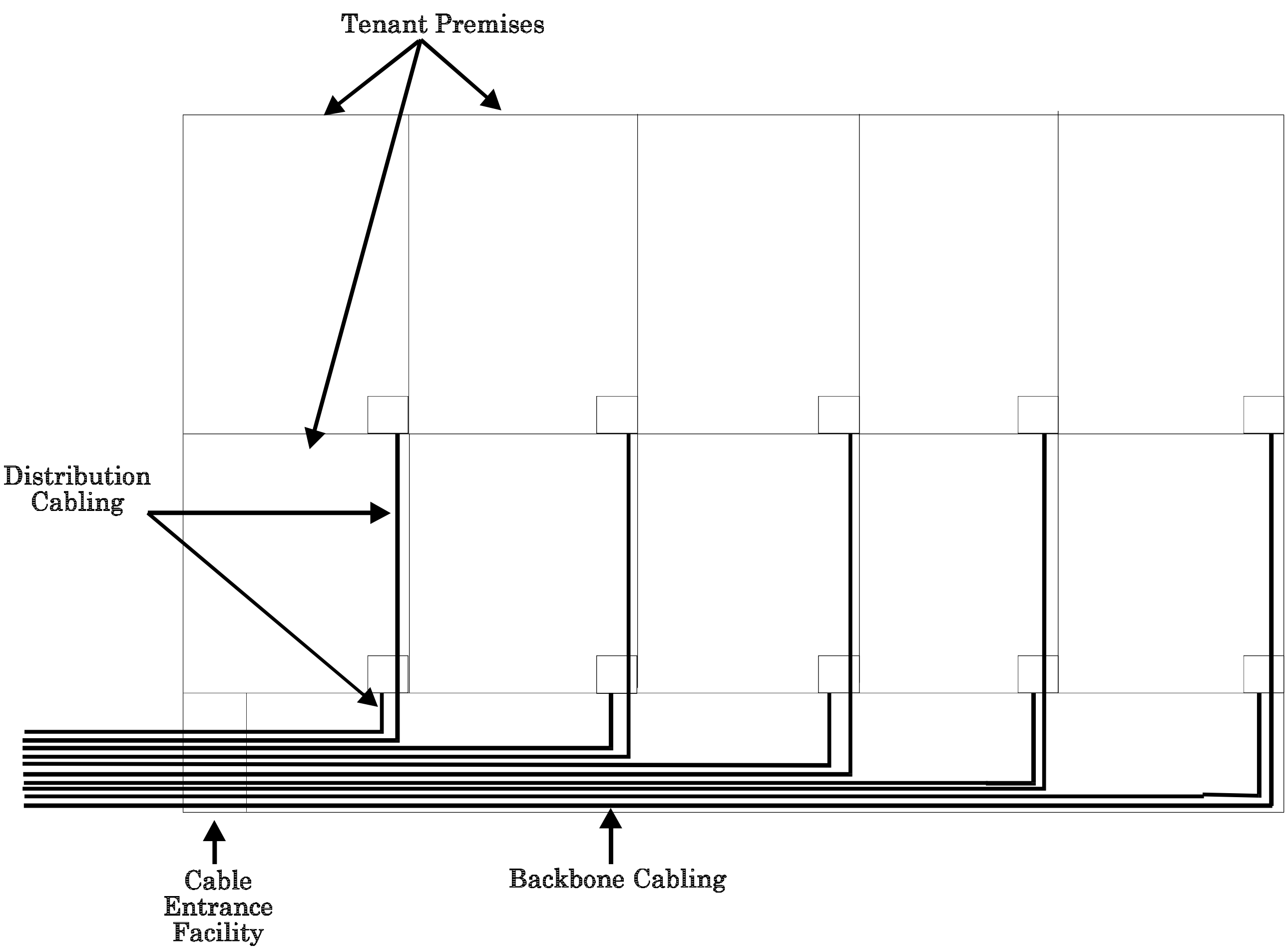

Figure 8-1: Example of Wiring Layout for a Strip Mall

8.1.1 Planning

This section will detail planning issues for a strip mall that along with Section 3 gives an outline for some of the issues that need to be considered when planning ISDN installation.

NOTE: When planning any wiring installation, be sure to account for all regulations for safety and fire, such as the Underwriter's Laboratory and the National Electrical Code. There may also be local codes that have additional requirements.

For the purpose of this section, two terms are defined here. The **tenant premise** is defined as the particular area in which the tenant who is installing ISDN resides or occupies. Examples of tenant premises for strip mall layouts are stores and a suite of office space. The **tenant entrance point** is defined as the point where the tenant's wiring responsibility begins. Note that this point will not necessarily coincide with the demarcation point. Further, this may not be the point where the wiring first enters the tenant premise. Thus, the tenant entrance point may not necessarily reside on the tenant premise and the tenant may be responsible for some wiring outside of the tenant premise.

The following are the steps that are necessary for determining the wiring needs for the ISDN service.

1) Find the demarcation point.

Using the information given in Section 2, determine the location at which the responsibility of the service provider ends.

2) Find the tenant entrance point, if it is different from the demarcation point.

The tenant entrance point will depend on the policy of the building landlord or owner. Not only will the demarcation point vary from structure to structure, but the tenant entrance point can vary from the demarcation point depending on where the inside wiring responsibility resides.

3) Determine the type and number of ISDN devices that will be used on the tenant's premise.

This is dependent on the application needs of the people in the tenant premise. As mentioned in Section 3.2.1, a common set of terminals on the premise will reduce the number of different wiring configurations that will be necessary on the tenant premise. While this will determine some of the minimal wiring needs, step 4 will also drive additional wiring considerations.

4) Determine where the U interface and S/T interface will reside.

The first location where the S/T interface can begin is at the demarcation point. It is recommended that if the tenant entrance point is not the same as the demarcation point, that the S/T interface start no earlier than the tenant entrance point. Further, it may be important to have the S/T interface begin on the tenant premise. Because the area between the tenant entrance point and the demarcation point is not within the responsibility of the tenant, the tenant has no control over the wiring and, therefore, may not want to run the S/T interface over that wire. Also, if the NT1s reside off of the tenant premise, there must be guarantees that the tenant can gain access to the area if the NT1s need to be re-configured or troubleshooting becomes necessary.

5) Determine the future ISDN needs of the tenant's premise.

The bottom line is to plan ahead. Even if only a few ISDN lines are being installed currently, determine whether current POTS lines will be able to be transitioned easily to ISDN, if that change needs to be made in the future.

6) If the tenant entrance point is not the same as the demarcation point, determine what sort of wiring exists between the demarcation point and the tenant entrance point and who is responsible for this wiring.

There are several considerations for the wiring between the demarcation point and the tenant entrance point. It must be adequate for carrying ISDN services and, thus, must meet the minimum cable requirements described in Section 4. It must contain the required number of wires from the demarcation point to the tenant entrance point. It is important to know who is responsible for this wiring. This will be necessary to address issues such as repair and maintenance as well as what needs to be done in the case where new wire needs to be run from the demarcation point to the tenant premise point to accommodate ISDN service.

7) Ascertain the current wiring layout and limitations inside the tenant premise.

Refer to Section 3.1.1 for further information.

8) Determine whether new or existing wiring in the tenant premise can be used.

Based on the results of step 7, determine if existing wiring can be used. If there is any doubt, it is recommended that new wiring is run for ISDN services.

8.1.2 Wiring

Good wiring practice should be exercised in order to provide for ease of installing and maintaining the wiring. An overview of some of considerations can be found in Appendix A.

Terminology has been used throughout this document referring to horizontal and vertical wiring. For a strip mall layout, the vertical (backbone) wiring is actually laid out horizontally and the horizontal (station) wiring may actually be vertical. When backbone cabling is laid horizontally, telecommunications closets that provide cross-connect points for the station wiring are often referred to as backbone closets.

The final wiring configuration on a tenant premise will be determined by where the NT1s and power are located. Refer to the appropriate sections in Section 5 and Section 6.2 for the wiring configuration that meets the needs of the applications that are intended to use ISDN service.

8.1.3 Powering

Powering considerations for a strip mall is similar to a multi tenant high rise. The difference is that a strip mall may take up more square feet of ground space. Multiple tenants are housed in one structure where ISDN service may or may not enter a central closet.

For a strip mall environment, power for the telecommunications equipment can be supplied through local power sources, remote power sources or distributed power sources. The choice may depend on a number of factors including:

- the number of ISDN service outlets to be supported,
- whether there is sufficient room for several power sources in a remote location (e.g., equipment room or telecommunications closet),
- can the existing power grid within the building support power for the ISDN service,
- if existing wiring is to be used, can it support power transmission from the remote location to each service outlet,
- placement of the NT1s; for example, if the NT1s are rack mounted in an equipment room, then it may be desirable to have a power source near or in the equipment room.

Section 5.4 contains additional guidelines on choosing the size of the power sources, and guidelines for backup power systems.

9. ISDN Specific Guidelines for Specialized Applications

This section contains information that is specific to certain specialty applications. While Sections 3, 4, and 5 have provided general information that is applicable to most building types, this section provides wiring configuration and planning information that is dependent on the building type and the occupancy of the building. Specialized applications are defined in this document as buildings that may fall into one of the configurations already mentioned in this document (i.e., single-tenant high rise), but due to the function of the occupants, requires additional wiring and/or powering considerations. Section 9.1 contains information on emergency service buildings, such as hospitals. Section 9.2 contains information on other miscellaneous building types.

9.1 Emergency Service Buildings

Emergency Service Buildings, due to the criticality of their function, have certain additional considerations that other occupants of similar building structures might not. Most of these considerations stem from the importance of maintaining communication at all times. Therefore, Emergency Service Buildings will have additional wire fault and power considerations. Emergency Service Buildings include, but are not limited to:

- Hospitals
- Police Stations
- Fire Stations.

It is recommended that there be backup cable paths as well as backup power in order to ensure that communication links can always be maintained. Each building should have a separate service entrance. These service entrances should be at different locations at the building. Thus, if a cut or disaster occurs to the cables at the main entrance, the duplicate entrance cables may still be intact.

While labeling, complete and detailed records, and a good cable management system are always recommended, their existence in this environment is much more critical in order to trace failures in a quick and efficient timeframe.

9.1.1 Emergency Services Powering Needs

Powering of ISDN with emergency services has one special consideration. This special consideration is backup time. Emergency services require operation to continue when all other services are out of operation. ISDN service with its customer premise power requirements needs to be carefully considered for use with emergency services.

9.1.1.1 Backup Power Alternatives

There are several methods of providing backup power for ISDN premise equipment. They are battery, inverters, and motor generators.

Inverters provide backup power by relying on battery power to maintain the power. Battery direct current enters the inverter where it is converted into 110 volt AC. The inverter then provides AC to the rectifiers for the ISDN communications system.

Battery backup for communications systems works well for the short term. However extended power outages will cause the batteries to deplete. Once the batteries are depleted, communication is lost. AC power must be restored to restore communications, which will also recharge the batteries. Backup times must be carefully considered to provide service without interruption.

Motor generator systems work on the principle where the loss of AC power starts the motor. The motor runs, generating DC or AC power to the equipment. However, it can take anywhere from several seconds to several minutes for the motor generator to come on line and power the equipment. During this time, communication is lost.

A mixture of backup alternatives provides the best solution. Large battery banks are avoided by providing batteries to cover the start up time of the motor generator. The motor generator can then power the communications equipment for long periods, as well as charge the battery. If necessary, the motor generator can be shut down for a small period of time. Again, the battery takes over. If used in this way, power is not lost.

9.1.1.2 Types of Powering

The powering at emergency services can be done centrally, distributively, or locally.

Central powering is done in one location at the emergency service site. From there it is distributed to all necessary locations.

Local powering is done at the station location. This is very costly for use in the emergency services environment.

Distributive powering is done through out the emergency services site. Multiple power supplies are used to provide power to the stations.

It is important to note that emergency service sites may require multiple equipment functions to keep operating. As such, in the ISDN communication scenario there may possibly be more than one type of powering used. The primary power may be distributive, with backup power being central. The backup power would come on line and provide power to the distributive rectifiers to bring the communications back on line.

9.2 Miscellaneous Buildings

Many building types have their own standards for wiring. Buildings that may have these standards and other additional wiring considerations include, but are not limited to:

- Government and military installations
- Airports
- Radio Stations
- TV Stations
- Computer Centers.

While it is important to adhere to certain requirements and recommendations provided earlier in this document to ensure operation of ISDN services, it is critical that the standards and requirements of the building type are followed when wiring for certain specialty application buildings. For example, an airport may have additional restrictions and regulations for electromagnetic interference, sharing cabling with other services, and distance between cables carrying different services that need to be considered when planning an ISDN installation.

Each building should have a separate service entrance. These service entrances should be at different locations to the building. Thus, if a cut or disaster occurs to the cables at the main entrance, the duplicate entrance cables may still be intact.

Appendix A - Wiring Practices

A.1 Wire Management

The purpose of wire management is to ensure that cables are labeled, easy to locate, securely fastened to prevent injury, and to promote flexibility in the telecommunications system. Proper wire management will make it easier to determine things such as the number of free pairs and whether a terminal can be attached to a certain outlet.

Within telecommunications closets (or equipment rooms) the use of patch panels will enable ease of interconnection. Proper labeling of these panels will make the routing of connections easier to manage.

At the service outlet, proper labeling will help to determine what sort of equipment may be attached to the outlet. Wired office furniture or furniture with pre-installed wire ducts will secure wiring and make wiring runs more manageable.

Documentation of the wiring system is of major importance. A database should be maintained with someone responsible for keeping it up to date. It should contain information on cables, conduit, interconnection panel, as well as whether the line is open or in use.

A.2 Conduit Systems

Several types of Conduit systems are described here, along with some advantages and disadvantages. The type of conduit system selected will depend on the number of cables needed, and building characteristics. Conduit systems will help to make the replacement of horizontal and vertical cabling easier and more cost-effective.

- In-floor systems - These systems consist of a cellular matrix, or an underfloor duct, where the cable is run through the matrix or duct. These systems are typically installed while the building is being constructed. They are not usually easy to install in existing buildings, or to expand at a later date.

- Raised floors - Raised floors consist of square metallic modules such as those found in computer rooms or laboratories. These systems are well suited for both existing and new buildings, and they generally have an adequate capacity.

- Ceiling systems - In ceiling systems, the cable is run through ceiling ducts, which are hidden behind the suspended tile ceiling, and dropped down through the walls to the service outlets. Ceiling systems are one of the most common systems for cable distribution.

- Surface Raceways - These are metal or plastic tubes that are fixed to walls with brackets. These systems may be less expensive that others, especially for existing buildings, but because they are not as large as other types of ducts, they have limited capacity.

References

NIUF/ICSW/BRI/060, **“ISDN Wiring and Powering Guidelines for Residence and Small Business (Version 2),”** North American ISDN Users’ Forum, 1995.

Electronic Industries Association, **EIA/TIA-568 “Commercial Building Telecommunications Cabling Standard,”** Electronic Industries Association, 1995.

Electronic Industries Association**, EIA/TIA-569** "**Commercial Building Standard for Telecommunications Pathways and Spaces,**" Electronic Industries Association, 1990.

Electronic Industries Association, **EIA/TIA-607,** "**Grounding and Bonding Requirements for Telecommunications in Commercial Buildings,”** Electronic Industries Association, 1991.

Building Industry Consulting Services International (BICSI),**Telecommunications Distribution Methods Manual,** GTE, 1985.

United States Federal Communications Commission Rules and Regulations Volume 7, Part 68, **Connection of Terminal Equipment to the Telephone Network**, U.S. Government Printing Office, 1991.

National Fire Protection Association **National Electrical Code**, National Fire Protection Association, 1990.

Underwriter’s Laboratories, Inc., **UL 1459 Standard for Telephone Equipment**, Underwriter’s Laboratories Inc., 1994.